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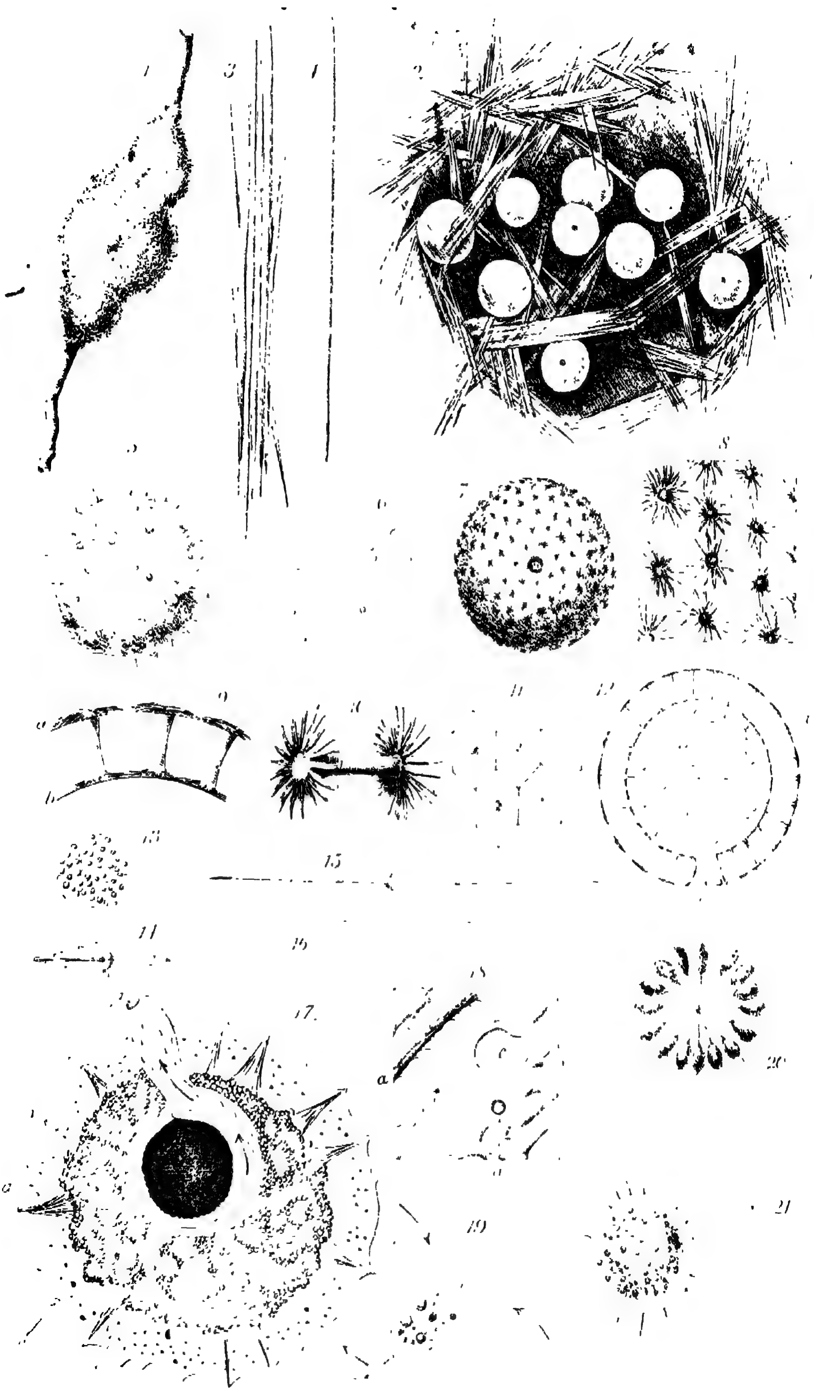

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POPULAR SCIENCE REVIEW.

THE COMMON FRESH-WATER SPONGE—*Spongilla fluviatilis.*

By PROFESSOR W. C. WILLIAMSON, F.R.S.

WHEN fishing amongst fresh waters, in ponds, reservoirs, or near the sides of large docks, the naturalist frequently brings to the surface masses of a green slimy substance, adherent to stones, or, more frequently, to sticks (fig. 1), posts, or other pieces of dead wood. The object is not attractive to the eye, and the impression it makes upon the olfactory sense is not such as to invite closer acquaintance on the part of the unscientific observer. But to the naturalist the *Spongilla*, or fresh-water sponge, is one of the most interesting of organisms. Its existence has long been known to students of nature. Ray and Pulteney were familiar with it. Linnæus received it from one of the Swedish lakes with intense satisfaction, and correctly discerning its close affinity to the marine sponges, he included it amongst them, giving to its two chief varieties the specific names of *fluviatilis* and *lacustris*, by the former of which it is still generally known. But though it has so long been a familiar object to zoologists, surprisingly little was known of its real history until within the last few years. In common with its spongy relatives, its claim to rank amongst animals has been extensively questioned. Mr. J. Hogg, some years ago, noted various phenomena, which led him to conclude that it was a plant. He specially observed that its green colour was largely dependent upon the action of light—a plant-like feature which had much weight with him and those who, like him, believed the *Spongilla* to be a vegetable form.

Within the last few years, thanks to the labours of Carter, Lieberkuhn, and Bowerbank, but especially to the first-named

of these experienced observers, our acquaintance with the *Spongilla* has assumed a much more definite and correct character. Most naturalists now admit its animal nature, whilst they recognise fully its many points of close affinity to the lowest plants. Its position in the scale of organised forms is near the base of the organic pile, where plants and animals present so many points in common that the most skilled students have ever been at a loss to define the boundary line between the two kingdoms. Speaking scientifically, Spongilla is a rhizopodous animal, belonging to the same class as the sponges, foraminifera, polygastric infusoria, and their various allies.

There are probably few parts of the world where it may not be found. It is common in the ponds of our own country, as well as in various parts of Europe. Carter found it in the tanks of Bombay; and, like many other low types of organization, it has doubtless a cosmopolitan range. The finest specimens I ever obtained were from the huge posts supporting some of the gates of the London Docks.

When small specimens are met with they appear as slimy, roundish masses (fig. 1), not unlike many of the gelatinous fresh-water Algæ; but as they advance in growth they assume various forms, partly dependent upon the situations in which they live. They usually occur as irregular masses, clustering round the object to which they attach themselves, presenting slight appearances of projecting lobes and ridges. Occasionally they become slender branching objects, from six inches to a foot in length—a type more frequently seen in running streams than in stagnant waters.

The unaided vision readily detects three distinct elements in the organisation of Spongilla: the investing jelly, or *sarcode*; an internal skeleton of harder and brittle material (fig. 2*a*), and multitudes of small yellowish seed-like bodies (fig. 2*b*), especially abundant towards the central and lower parts of the organism. When removed from the water and dried the *sarcode* almost disappears, leaving a very brittle mass (fig. 2), which the slightest pressure reduces to fragments. A low microscopic power demonstrates that this friable structure is an aggregation of siliceous spicula and round seed-like bodies, cemented together by the dried up *sarcode*.

In endeavouring to record the chief points that have been ascertained respecting the minute history of Spongilla, we are met by the difficulty that though many have written about it, its real observers have been few in number and recent in time. This would constitute no difficulty if the few were agreed; but in some important details this is not the case. Such discrepancies amongst the historians of the lower plants and animals often arise from the fact that these organisms have many-sided histories; and it

is only by the combined labours of many observers that their various phases of life and structure are harmonised. At present we are mainly dependent upon the excellent observations of Carter and Lieberkuhn, but much further inquiry will be needed before the history can be completed.

The skeleton consists mainly of numerous minute siliceous spicula, combined to form small irregular rods (fig. 3), which join each other at obtuse angles, to produce a very irregular network (fig. 2). Whether the spicula are bound together into rods, and the rods into a network, by any other material than sarcode is doubtful; no other cement has hitherto been satisfactorily shown to exist. Most of the spicula are long, slender, and smooth, pointed at each end (fig. 4), but others exist less abundantly in which the surface is muricated (fig. 18*a*).

The gelatinous investment, or sarcode, consists of an aggregation of numerous atoms which may be termed *sarcoids*, each one closely resembling a true Amœba in many of its aspects and actions. Various observers have noted that when the sarcode is broken up into fragments, in water, each portion is a more or less tremulous mass of sarcoids, and displays cilia projecting from its outer margin (fig. 5). Each sarcoid (fig. 6) exhibits movements resembling those of Amœba, pushing out portions of its substance and retracting others. According to Lieberkuhn, these movements are confined to the non-ciliated portions of the sarcode. Lieberkuhn terms these separate atoms *cells*, explaining, however, that he has never seen them invested with a true cell membrane. This use of the term is objectionable, though probably each sarcoid may be regarded as identical with the protoplasmic mass upon and by which the true cell membrane is formed, in both the animal and vegetable kingdoms. That such is the case is the more probable, since each sarcoid contains at certain seasons a nucleus and nucleolus: but for the present the use of the objectionable term is unavoidable. Each so-called cell is about $\frac{1}{1200}$ inch in diameter, the nucleus being $\frac{1}{2500}$, and the nucleolus $\frac{1}{9000}$. Thus we may legitimately regard the sarcode as being virtually a mass of Amœban sarcoids, combined to form a compound organism. We shall recur to the structure of the sarcode in describing some of Mr. Carter's important observations on the development of Spongilla.

We have already referred to the existence of numerous large seed-like bodies (fig. 2*b*) in the interior of the organism—objects commonly sold by dealers in microscopic objects under the name of spores, or gemmules of Spongilla. These are the most curious and characteristic features of Spongilla, and require a more elaborate description.

They are spherical bodies (fig. 7), with a small spot or aperture (fig. 7*a*) called the hilum on one side. I have observed that.

when dried, half the gemmule shrinks within the opposite half, producing a concavo-convex structure, and that the hilum is almost always on the concave side; indicating that the soft contents of the gemmule are firmly attached to the hilum, drawing it inwards when the former shrink from desiccation. When the exterior of the gemmule is examined under a moderate power, it appears to consist of an aggregation of stellate discs, closely packed (fig. 8), to form a continuous surface. On breaking up the gemmule, each disc is seen to be one extremity of a siliceous body, like a pair of toothed wheels on an axle (fig. 10). Ehrenburg described similar bodies under the generic name of *Amphidiscus*, hence these objects are now known as amphidiscs. They are placed with their axles perpendicular to the surface of the gemmule (fig. 9), hence their opposite stellate extremities form two continuous parallel strata of siliceous matter (fig. 9*a*-*b*), investing the gemmule. These amphidiscs are imbedded in a coat of gelatinous substance, whilst their inner extremities rest upon a coriaceous capsule, the surface of which is covered with hexagonal areolæ (fig. 11). Within this capsule are two kinds of cells—an outer nucleated series (fig. 12*a*), which Carter believes to be the instruments constructing the capsule, and an inner or central mass (fig. 12*b*), consisting of cells closely corresponding with the ordinary sarcoids, but differing in the circumstance that they contain numerous ovules or reproductive germs (fig. 13). In due season these cellular contents are discharged through the hilum (fig. 12*a*) into the water, and undergo a remarkable development, which has been watched by several observers, but most successfully by Mr. Carter, whose observations on this point throw an important light upon the general structure, as well as the growth of the Spongilla.

A few days after placing a gemmule in water, Mr. Carter found that a white flocculent substance had escaped through the hilum. Under the microscope the discharged substance appeared to have a flat, transparent, irregular margin, containing numerous vesicles; whilst in its central portion were the "ovi-bearing," or reproductive cells. Almost coeval with the discharge of the contents of the gemmule was the appearance of two kinds of siliceous spicula, which are formed in the interior of special nucleated cells. One of these is the ordinary double-pointed spicula (fig. 4), which appears within an elongated cell (fig. 14). It first presents itself as a delicate line, but rapidly grows by external additions, until it attains its full dimensions. These additions are commonly made more quickly at one (fig. 15), or occasionally at more points (fig. 16) than throughout its entire length; so that in its half developed condition it presents one or more bead-like inflations (figs. 15-16), which disappear when the growth of the spicule is completed. The spicula soon outgrow the cell in

which they first appear; but in what way successive additions are made to them after their dependence on their parent cell ceases has yet to be ascertained. As these spicules are formed they are removed by the sponge-cells to the place where they are ultimately needed, as Mr. Carter observes, "with as much instinct as that which characterises the arrangement of the bits of stick in an ant-hill."

When the growth of the sponge-mass has made some progress, the formation of a distinct investing membrane (fig. 17*a*), out of what was the flat transparent border, becomes obvious. This membrane is gradually detached from the central ovi-bearing cells, either by the shrinking of the latter or by the protrusion of bundles of large smooth spicula (fig. 17*b*), which force it outwards, leaving, here and there, open spaces between the membrane and the central cell-mass. The membrane contains numerous small spiniferous spicules (fig. 18*a*) scattered through its substance. There are also spread over the membrane numerous leaf-like nucleated cells (fig. 18*b*), resembling a compressed layer of multifid leaves, but which are polymorphic, constantly changing their forms, as well as their positions, and containing one or more contractile vesicles. Amongst these cells are numerous apertures (fig. 17*c*), which, according to Carter, have the power of opening and closing (fig. 18*c*, *d*, *e*); but which at their maximum rarely exceed $\frac{1}{700}$ inch in diameter. It appears to be through these apertures that the food passes into the cavity between the investing membrane and the parenchyma.

The parenchyma (fig. 17*d*) consists of a cellular mass permeated by canals (fig. 17*e*, *f*), respecting the ultimate structure of which there is much reason for doubt. The canals are regarded by Carter as of two classes; the one a series of afferent canals fig. 17*f*) opening into the parenchyma from the cavity of the investing membrane; whilst the other he considers to be a distinct efferent set (fig. 17*e*), not communicating with the afferent ones, but terminating in a single tube (fig. 17*g*), which projects from the periphery of the organism and constitutes an excretory outlet. The spaces between these canals are occupied by a gelatinous substance full of peculiar cells or sarcoids and large smooth spicules. Some of the cells are ciliated (fig. 6*c*-*d*), each protoplasmic atom having a single cilum, whilst others are unciliated (16*a*-*b*), but all are polymorphic. The exact arrangement of these cells in the parenchymatous mass is uncertain. At one time Carter thought he had satisfactory evidence that they were grouped in the interior of a parent cell, in the centre of which their undulating cilia were continually vibrating; but he subsequently ascertained the incorrectness of this explanation, and inclined to the belief that they were arranged round the exterior of primary cells, the cilia being external to

the latter instead of internal. On this point further observations are much needed; but both Carter and Lieberkuhn have noticed this tendency to form compound groups of sarcoids. It is evident that a period arrives when the Spongilla exhibits a disposition to break up and allow the ciliated cells to move off as independent individuals. When they do so each one becomes more or less pedunculated (fig. 19), contains a contractile vesicle or vesicles, as well as a remarkable greenish granule, is polymorphic, and by means of its single cilium sets up distinct currents (fig. 19*d*) in the surrounding water. But besides these single protoplasms there are occasionally compound groups which become detached under another shape. Ehrenberg described, under the name of *Uvella*, a genus of infusorial creatures, which formed clusters of monads radiating from a common centre to which they were all attached. Similar clusters sometimes present themselves on the breaking up of Spongilla (fig. 20). These were noticed by Carter, and similar groups were observed by Lieberkuhn amongst what he regarded as spermatozoa. How far the Uvella-like arrangement of the ciliated groups seen by these two observers represent the same thing is uncertain, but both indicate a disposition in Spongilla towards these radiant arrangements. Under other circumstances detached portions assume the form of Actynophrys (fig. 21), as is not uncommon amongst other rhizapods. The observations of Lieberkuhn have revealed some interesting facts additional to those recorded by Carter. He shows that in many cases the living Spongilla is supported upon a dark brown earthy mass, often several inches thick, consisting of empty shells of gemmules with their amphidiscs, various siliceous needles, and decayed sarcode. In these dead portions the gemmules are particularly abundant. In the deeper parts of the living sponge and in the neighbourhood of the dead portion he found, in addition to the ordinary brown gemmules, others of a shining white colour, and some in which the outer shell was exceedingly thin and easily broken up. On dissecting portions of the sponge containing these peculiar objects under water, he obtained isolated whitish ill-defined globular pieces, of about the size of the gemmules, and which he believed to be the latter bodies in an imperfect state of development. They distinctly exhibited two substances entering into their composition—viz., an outer one having about the same refractive power as the ordinary cells of the sarcode, and an inner mass which was highly refractive. Both these layers resolved themselves, under pressure, into aggregations of cells. The inner ones corresponded very closely with those already described from the centre of the brown gemmules, adhering firmly together, refracting the light strongly, and having large fat-like granules interspersed. These cells or sarcoids were like

the common sponge cells, polymorphic. But the chief interest of these masses was connected with their investing covering, which consisted of a layer of firmly cohering cell-like globules. Some of the latter were also like the common sponge-cells, being granular and nucleated; but others enclosed amphidiscs in various stages of development. The most rudimentary of these spicula only appeared like slender rods slightly thickened at each extremity; in a second form these rods had very delicate *setæ* radiating from and arranged at right angles with their thickened ends. Thus the amphidiscs, as we have already shown from Carter's observations to be the case with the pointed spicula, begin to exist as slender rods, which become thickened by additions to their external surfaces; both the spicula and the amphidiscs being formed in the interiors of sarcoids, or protoplasmic sponge-cells.

Besides the reproduction by gemmules, already described, various indications have been seen suggestive of other modes in which the species is multiplied; but considerable doubt attaches to many of these, from the circumstance that various infusorial animalcules find their way into the sarcode of Spongilla, which may readily be mistaken for essential parts of the organism. Both Carter and Lieberkuhn recognise numerous groups of germ-cells in the parenchyma, *the contents* of which become developed into sponge-cells. Lieberkuhn terms these groups *germ-granules;* but the latter observer has seen in addition what he terms "swarm-spores." On leaving recent sponges for some hours in water he observed free atoms moving about having a length of about $\frac{1}{35}$ and a width of $\frac{1}{50}$ of an inch at their broadest part. These objects swam about freely for one or two days, and then sank to the bottom of the water, where they underwent a further development. Each one soon expanded into a structureless mass, containing fine siliceous needles. On the 20th day the mass had not only become larger but contained all the constituent elements of young sponges—viz., smooth and muricated spicules, polymorphic cells, large and small granules, some germ-granules, and external cilia effecting locomotion. Lieberkuhn thought that the cilia were attached to a single epithelial layer of contiguous, but not mutually compressed, cells, each cell having a single cilium. These observations, taken along with others already referred to, demonstrate the strong tendency existing in spongilla to the development and liberation of mono-ciliated sarcoids or sponge-cells. Each swarm-spore developed into an organism having a structureless (?), gelatinous cortical portion and a more distinctly organised medullary mass. Lieberkuhn's detailed descriptions of the appearances presented by these structures, in the course of their development, differ widely from those noticed by Carter in the products of the brown gemmules; but in

both instances a distinct separation of the organism into cortical and medullary portions took place. Lieberkuhn also notices in his *swarm-spores* an abundance of what he terms "germ-granules." These are cells, sometimes $\frac{1}{1800}$ inch in diameter, which, in addition to the ordinary granular matter, contain more distinct granules, regarded by Lieberkuhn as reproductive. Carter's ovi-bearing cells are probably identical with the above. Though it is not always easy to identify the objects described by individual writers, there is no doubt that the medullary substance, both of the developing gemmules of the swarm-spores and of the matured sponge, abound in cells (fig. 13) or sarcoids filled with definite granules, which latter, in their turn, frequently develop into sarcoids. These reproductive sarcoids are sometimes scattered through all parts of the Spongilla, at others aggregated into groups. Carter found what he regarded as "zoosperms," and Lieberkuhn believed that he had discovered "spermatozoa" in Spongilla; but I cannot regard the existence of these fertilising cells as proved in either of these instances. The possibility of feeding the Spongilla is a much better established fact. Carter introduced carmine into the water, and, after a while, discovered that particles of the colouring matter had been carried, through the apertures of the investing membrane, into the canals, whence they had reached and become imbedded in the substance of the sarcoids, as would have occurred amongst true Amœbæ under similar conditions.

DESCRIPTION OF THE PLATE.

FIG. 1. Young Spongilla investing a small branch.

„ 2. Fragment of Spongilla dried up: *a*, network of spiculs agglutinated by desiccated sarcode; *b*, reproductive gemmules.

„ 3. Rod of skeleton composed of aggregated smooth spicules.

„ 4. Single smooth spicule of No. 3.

„ 5. Small detached mass of sarcode (after Carter).

„ 6. Separate "cells" or sarcoids: *a-b*, unciliated; *c-d*, mono-ciliated (after Carter).

„ 7. Separate siliceous gemmule: *a*, hilum.

„ 8. Fragment of the exterior of the gemmule with the amphidiscs in position, as seen by transmitted light.

„ 9. Vertical section of fig. 8: *a*, outer layer of stellate discs; *b*, inner layer.

„ 10. Detached amphidisc.

„ 11. Portion of the surface of the membrane investing the medullary mass of the gemmule (after Carter).

„ 12. Diagram of section of a gemmule: *a*, coriaceous investing membrane; *b*, medullary mass of "cells;" *c*, layer of amphidiscs; *d*, hilum.

FIG. 13. Ovi-bearing "cell" of medulla of a gemmule.
„ 14. Elongated nucleated "cell," with a smooth spicule forming in its interior.
„ 15-16. Smooth spicule partly developed.
„ 17. Young Spongilla developed from a gemmule : *a*, investing membrane ; *b*, bundles of spiculs detaching investing membrane from medullary mass ; *c*, apertures in investing membrane ; *d*, medullary parenchyma ; *e*, efferent canals ; *f*, afferent canals ; *g*, common outlet of efferent canals ; *h*, remains of gemmule (after Carter).
„ 18. Portion of investing membrane of fig. 17 : *a*, muricated spicule ; *b*, leaf-like cells ; *c*, afferent aperture in membrane, open ; *d*, ditto, partly closed ; *e*, ditto, closed.
„ 19. Free pedunculate "cell," or sarcoid of Spongilla : *a*, aqueous currents (after Carter).
„ 20. Uvella-like group of sarcoids (Carter).
„ 21. Actinophrys form assumed by portion of Spongilla (Carter).

THE HURRICANE, THE TYPHOON, AND THE TORNADO.

By PROFESSOR D. T. ANSTED, F.R.S.

IN that beautiful and picturesque group of the West Indian Islands called the Virgin Islands, of which St. Thomas and Tortola are the largest and most inhabited, on the 29th October last, at nine o'clock in the forenoon, the weather was fine and the sky clear as usual, and the barometer stood at 30 inches. The harbour of St. Thomas was full of shipping, and in various sheltered spots between the harbour and the adjacent islands the steamers of the West India Mail Steam Ship Company were collecting, to exchange cargoes and passengers. No one at that hour seems to have foreseen mischief, but a storm was then approaching that in a very short space should bring destruction on everything exposed to it. Within half an hour the barometer had fallen seven-tenths of an inch, and the hurricane commenced. It advanced rapidly, the wind changing as the storm neared. For a time it seemed that the storm would be unimportant, but towards noon the whole of the district near the town and to the east was in the centre of one of the great tornadoes that occasionally desolate the West Indies. At half-past twelve there was a cessation of wind, but the barometer showed a pressure of little more than 28 inches. The sky was then black and the darkness so thick that nothing could be seen either of cloud or sky. Deluges of rain fell, hailstones consisting of angular fragments of ice fell on the earth, earthquake shocks were felt, huge sea-waves swept over the earth, and none either at sea or on shore was safe from the terrible force of this great storm of wind. At this time the central axis of the storm passed over the town. By 5 P.M., the storm having lasted eight hours, all was over; every ship was wrecked, every building destroyed, and a large part of the population ruined. Upwards of a hundred lives were also sacrificed. Such was the real meaning of the few terrible words flashed across the Atlantic by the telegraph a few days after the occurrence. The details came later. After a few days the storm was followed by further and more serious earthquake shocks, and all the adjacent islands, especially Tor-

tola, appear to have suffered seriously. Three weeks later a severe earthquake shook the island, destroying much that had been spared by the storm.

About thirty years before, on the 2nd August, 1837, a very similar storm travelled over almost exactly the same path, and was accompanied by similar phenomena. Then also there was a fearful wind felt, torrents of rain fell, hailstones consisting of angular fragments of ice were picked up by the terrified inhabitants, and earthquake shocks then also assisted in the destruction. The great sea-wave came up over the land and carried back with it to the deep the evidences of the mischief done; and the destruction caused by the storm on the shipping in the harbour and in the seas around, as well as on all the buildings on the shore, by the wind, the wave, and the earthquake, was of the same nature, only carried to a still greater extent. Many other severe storms have happened since, and many are recorded that happened before. They were not dissimilar; but it does not often happen that such a complete and perfect parallel can be traced as is obtained by a comparison of the log of H.M.S. Spey, a packet-ship that visited St. Thomas a few days after the hurricane of 1837, with that recorded of the recent event. We quote the account from the admirable and well-known work by Sir William Reid "On the Law of Storms." It should be mentioned that the year 1837 was remarkable for two severe hurricanes in the West Indies, and several other great storms. On same year it is recorded that many severe earthquakes were felt in Mexico and several islands in the West Indies. It may be observed, as a further coincidence, that the hurricane of the 2nd August seems to have originated in the open sea to the east of the Virgin Islands, and not off the South American coast. This was the case also with the late hurricane of the 29th October.

August 6, 1837, A.M.—Arrived at Tortola. Here the hurricane (of the 2nd Aug.) has destroyed the town and several plantations.

P.M.—Came to an anchor in St. Thomas' harbour. Here the hurricane appeared to have concentrated all its power, force, and fury, for the harbour and town were a scene that baffles all description. Thirty-six ships and vessels totally wrecked all round the harbour, among which about a dozen had sunk or capsized at their anchors; some rode it out by cutting away their masts, and upwards of a hundred seamen drowned. The harbour is so choked up with wreck and sunken vessels that it is difficult to pick out a berth for a ship to anchor. The destructive powers of this hurricane will never be forgotten. Some houses were turned regularly bottom up. One large well-built house was carried by the force of the wind from off its foundation, and now stands upright in the middle of the street. The fort at the entrance of the harbour is levelled with the foundation, and the 24-pounders thrown down; it looks as if it had been battered to pieces by cannon shot. In the midst of the hurricane shocks of earthquake were felt, and to complete this awful visitation a fire broke out in some stores. Heavy tiles were flying about from the tops of the shaking and trembling houses,

killing and wounding many persons. One fine American ship, 500 tons, was driven on shore near the citadel, and in an hour nothing could be seen of her but a few timbers. Several fine merchant ships and brigs are at anchor, dismasted, with cargoes, and not a spar or rope for standing rigging to be had in the island. No place hitherto has suffered so much from a hurricane in all the West Indies as St. Thomas.

Terrible and fatal as were the great storms of 1837, whose results we are still lamenting, they are by no means the only, nor are they the worst, cases recorded of destructive hurricanes in the West Indian Seas. The great hurricane of 1780, which took place on the 10th October, was much more destructive and very far more fatal to human life than either of these, or even than both put together. On that occasion, at Santa Lucia, Admiral Rodney speaks of 6,000 persons having perished, while at St. Eustatia between 4,000 and 5,000, and at Martinique nearly 10,000 fell victims to the storm. At Barbadoes the loss of life exceeded 3,000, and in several of the other islands the result was disastrous, though in a less degree.* The amount of shipping destroyed was never accurately known, but among the losses may be mentioned a French convoy with 5,000 troops on board, which disappeared altogether during the storm. Part of the mischief seems to have been done by an earthquake, and a large part by great sea-waves, which washed over the land carrying everything away. At St. Pierre, in Martinique, a great sea-wave which rose twenty feet did more damage than the wind-storm itself.

All these and many other terrible storms, occurring between the months of July and November, have been especially destructive in and near the Gulf of Mexico and among the group of the West Indian Islands which shuts off that sea from the Atlantic. They have many points in common and belong to a class of storms happily rare in our climate, though frequent in tropical seas, both in the east and west. Their course in the Atlantic is well known. They take their start generally from the islands nearest the north-eastern corner of South America, and travel in a tolerably regular and almost parabolic curve, first to the N.W., then past the coast of Florida towards the north, and afterwards bearing more to the east, parallel to the North American coast, emerge again on the Atlantic near the banks of Newfoundland. They travel at rates varying from two to seven hundred miles per day for a distance sometimes exceeding 4,000 miles. They have a limited breadth, generally from one to four hundred miles, and within the limits of their path they move with so much system and regularity that with a few data we may almost tell by calculation the exact details of their course.

* It must be remembered that at this time the West Indian Islands were much more densely peopled than they are now.

Their courses have been frequently and accurately laid down on charts.

All these storms are of the nature of whirlwinds, and the direction and rate of motion of the wind in the hurricane is very different from the direction and rate of motion of the whole hurricane. Thus within a very short time, and in the same spot, during the late storm, the wind is described to have blown from various points of the compass; and while the whole storm was moving at the rate of ten or twenty miles per hour the wind within the storm was blowing at the rate of a hundred miles an hour. Almost every one must have noticed on a summer day a cloud of dust raised from the earth, whirling round leaves and twigs with great violence, and advancing with comparative slowness in a certain direction. The same, on a vastly larger scale, is the case with these terrible hurricanes. They twist round with fearful rapidity, on a central axis where there is generally a calm, the belt of storm moving steadily at the same time along the surface. Waterspouts at sea, and sandstorms in the deserts of Africa, are similar phenomena.

Originated chiefly because of the excessive heating of the earth in some special localities near the equator, and set in motion by opposite currents of air rushing in to fill the partial vacuum thus formed, it is not extraordinary that the central part of a whirlwind should be comparatively calm and be accompanied by electrical phenomena; nor need we be surprised at the mechanical force exerted where the wind is once set in motion. It is recorded that even small whirlwinds lift not only vast quantities of dust, but carry even fish into the air. The partial vacuum in the central part, where the pressure is reduced from 100 to 150 pounds on each square foot of surface, acts in the most extraordinary manner on buildings, not unfrequently forcing the windows and roof outwards, instead of blowing them into the building, and sometimes lifting a whole house from the foundation. The mere force of the wind moving with extraordinary rapidity, in a spiral and with a complicated motion (one motion round the axis, the other in a curved line in the main course of the storm), is sufficient to explain most of the wonderful things recorded of these phenomena. Some that verge on the impossible may, perhaps, owe a little to the fears and lively imagination of the describer.

The class of storms to which these great tropical hurricanes belong is now generally called *cyclonic*, from their moving round an axis in a circle, or rather spiral. Though producing their most striking effects in the tropics, and best known in the Tropic of Cancer, they are not limited to such latitudes; occasionally crossing the Atlantic into the temperate zones, and sometimes originating apparently near our own shores. The

great storm of 1859, which among other fatal accidents was the cause of the wreck of the Royal Charter off the mouth of the Mersey, and strewed our shores with wrecks, will long be remembered. This storm followed a distinct path through England, and in all respects resembled the hurricane of which we have just heard. It was less disastrous, because as we leave the tropics there are fewer of the causes at work that give intensity to atmospheric disturbances; but the course of the hurricane was similar, and though not accompanied by earthquake shocks, there was an amount of derangement of magnetic equilibrium both in the atmosphere and the earth, which proved clearly that the phenomena in question are not merely violent local winds, but have some peculiar characteristics and are the outward indications of something going on in the interior of the earth. There is reason to suppose that they may even be connected with changes and occurrences in open space, or in the sun itself, the centre of our system.

It was in the China Seas and in the Bay of Bengal that storms of this kind were first distinguished from ordinary tempests; and it was more especially the study of the storms of the Coromandel coast that enabled Colonel James Capper to point out (in 1801) that they were invariably whirlwinds or circular storms, while to Mr. Redfield, who succeeded him, we owe the determination of the fact that they are not merely circular or confined to one spot, but spiral, having a path on the earth as well as a revolution round an axis.

The East Indian hurricanes, of which we have unfortunately had a terrible example in the cyclone of the 1st November last, have been as frequent, as fatal, and as distinctly traced as the West Indian tornadoes. As in the case of the latter, there seems to be a singular resemblance between recent and former storms. Thus, on the 31st October, 1831, there was a hurricane in the Ganges, on which occasion 150 miles of country were flooded, and 300 villages with 10,000 persons destroyed. After 36 years the storm recurs almost on the same day. But these storms are very frequent, for in the very next year (1832) there was another great hurricane, on the 7th October, and six months afterwards a third, at the mouth of the Hoogley, when the barometer fell 2½ inches, or one-twelfth of the whole atmospheric pressure. In all these cases the nature of the storm, the existence of a spiral movement, and the limits of a path, were made out. Storm-waves advancing up the great rivers occurred on all these occasions, and are especially liable to do serious mischief. In the instance recently recorded in the present year, it appears that 30,000 native huts were destroyed, a thousand lives lost, and 600 native boats destroyed. The constant and sudden changes in the direction of the wind, after

occasional lulls, the limit of duration of the storm in any one spot, and the fact that the total diameter of the storm is rarely more than from one to two hundred miles, clearly place this hurricane in the class of storms we have been describing. It may be regarded as certain that while on the whole such storms take place at distant parts of the world at similar seasons, and may be even almost contemporaneous, they have no direct relation with each other. Thus, the path of the late West Indian storm, commencing on the 28th or 29th of October in the Atlantic, and running eastward and northward, could have no immediate reference to the storm in the Bay of Bengal that commenced on the 1st November and travelled northward. At the same time, it must not be lost sight of that about that season, and for some time both before and after, there has been unusual atmospheric disturbance in the Atlantic and also in the Indian Seas. Thus the problem to be solved in reference to the cause of cyclonic storms is one of very large dimensions, and the phenomena are numerous, complex, and very varied.

Several important facts may be noticed in most of the accounts of great cyclonic storms that have been carefully recorded. There are—First, the limit of space on the earth's surface over which such storms are common, and the fact that within this limit each storm has its own path and its own limits of breadth. Second, the approximate identity of these paths at very distant intervals, and the strict fidelity with which the principal phenomena are repeated. Third, the spiral or corkscrew motion of the storm round a central axis, the outer limit of the largest spiral being the extreme width of the storm. Fourth, the complication of earthquake shocks with the hurricane on those parts of the course of the storm where it is most destructive. Fifth, the electrical and magnetic disturbances frequently indicated. And Sixth, the occurrence of a great sea-wave during such storms sweeping over the lands, and exceedingly destructive to life and property. All these phenomena were observed during the late hurricane at St. Thomas and Tortola.

Leaving for the present the case of typhoons, waterspouts, and variable-wind storms, and confining ourselves to the region of the West Indies, it may be remarked that all the great hurricanes that have devastated the islands themselves, the shores of the Gulf of Mexico, and the east coast of the United States, have originated near the north-eastern extremity of South America, between latitudes 10° and 20° North and between 50° and 60° West longitude. Almost all have followed the direction of the islands to the peninsula of Florida, and have then passed on, grazing as it were the coast, and gradually diminishing in intensity till they re-enter the open Atlantic, near the island of

Newfoundland. The best observed have performed this whole path in a time varying from seven to ten days. They have sometimes been only partially traced, and in some of these cases the rate has been much more rapid. Some few have gone in a straight line towards Mexico. In these storms the path of the centre of the storm is always from the equator into the north temperate zone, but the whirl itself moves from north by west to south, and round from south by east to north, being the reverse direction to that of the hands of a watch. The diameter of the whirl, at first small, has gradually increased, the strength of the storm at the same time diminishing.* Thus the greatest intensity of each storm is near the centre of the whorl, and near the commencement of the path, and there of course are the most disastrous results produced. The smaller whorls of some great storms have not been more than 50 miles in diameter at first, but have increased to 500 miles. Others have been more uniform.

The limit of space occupied by these storms has been proved by the examination of the logs of ships in various positions, some within and others just outside the limit of the storm, and sometimes by the effect produced on land. The nature of the spiral motion is detected, and the magnitude of the spiral estimated, by the mode in which the storm returns to the same spot, and the very different quarter from which the wind blows within very short intervals. This is a characteristic of cyclonic storms; and a knowledge of the fact and its cause is extremely useful to shipmasters, enabling them in some cases to avoid altogether the storm, in others to steer out of it with little damage, while other ships less intelligently conducted have suffered serious injury or been entirely wrecked.

Few things are more remarkable than the exact repetition of the phenomena of great West Indian hurricanes. This has been shown by an example quoted at the commencement of this article. The following outlines, derived from recorded narratives of characteristic examples, will serve as a general account. Before the storm the weather is fine, clear, and excessively hot, with light shifting winds and a high barometer; if at sea the water is smooth. Suddenly the barometer falls, sometimes very much and very rapidly, at other times moderately, but almost always rapidly, and often some hours previously to change. The direction of the wind when the storm arrives depends on the part of the storm that first reaches the place; but it shifts rapidly and soon veers, in all cases backing round from east by

* This is not always the case, as in the great Barbadoes hurricane of 1837 the path of the storm at Barbadoes was about 130 miles wide, and had not increased to 200 miles when near Florida, a distance of nearly 1,500 miles.

north to west.* After a while the central axis arrives, and then there is a dead calm, which lasts for a short time—perhaps an hour. The wind then rises again, commencing almost instantaneously with a hurricane from the opposite quarter to that from which it had last blown. When the observer is at sea we find it described in such words as these: "The sea tremendous from the force of the wind; no tops to the waves, being dispersed in one sheet of white foam; the decks tenanted by many sea-birds in an exhausted state, seeking shelter in the vessel; impossible to discern even during the day anything at fifty yards distance; the wind representing numberless voices elevated to the shrillest tones of screaming" (Log of the Rawlins, Captain Macqueen, 20th August, 1837). On shore the case is somewhat different. Electrical phenomena and magnetic disturbances, and sometimes earthquakes, complicate the horrors, and the destruction, if not greater, is more seen and more easily described. In the account of the Barbadoes hurricane of 1831 we read, that "On the morning of the 10th August the sun rose without a cloud; at 10 A.M. a breeze that had been blowing died away; towards 2 P.M. the heat became oppressive; at 5 P.M. thick clouds appeared in the north, rain fell, and was succeeded by a sudden stillness and a dismal blackness all around except towards the zenith, where there was an obscure circle of imperfect light. Till 10.30 P.M., however, there was no sign of change; then lightning appeared in the north, and very unusual fluctuations of the thermometer were observed. All this time the storm was only approaching.

"After midnight the continued flashing of the lightning was awfully grand, and a gale blew fiercely from the north and north-east, but at 1 A.M. on the 11th August the tempestuous rage of the wind increased as the storm suddenly shifted and burst from the north-west and intermediate points. The upper regions were illuminated by incessant lightning, but the quivering sheet of blaze was surpassed in brilliancy by the darts of electric fire which exploded in every direction. At a little after 2 A.M. the astounding roar of the hurricane cannot be described by language.†

"About 3 the wind abated and the lightning ceased for a few moments at a time, when the blackness in which the town was enveloped was inexpressibly awful. Fiery meteors were

* It is well known that when the wind changes in the direction of the motion of the hands of a watch, north by east to south, and so by west to north, there is a probability of fine settled weather. The reverse motion indicates bad weather, and is called by sailors the "backing" of the wind.

† The commanding officer of the 36th Regiment, who had sought protection by getting under the arch of a lower window outside his house, did not hear the roof and upper story of the house fall, and only found it out by the dust caused by the fall.

presently seen falling from the heavens; one in particular, of a globular form and a deep red hue, was observed by the writer to descend perpendicularly from a vast height. On approaching the earth it assumed a dazzling whiteness and an elongated form, and on reaching the ground splashed around in the same manner as melted metal would have done, and was instantly extinct.* A few minutes afterwards the deafening noise of the wind sank to a solemn murmur, or rather a distant roar; and the lightning, which from midnight had flashed and darted forkedly with few but momentary intermissions, now for nearly half a minute played frightfully between the clouds and the earth with novel and surprising action. The vast body of vapour appeared to touch the houses, and issued downward flaming blazes, which were nimbly returned from the earth upward.

"The moment after this singular alternation of lightning the hurricane again burst from the western points with violence prodigious beyond description, hurling before it thousands of missiles, the fragments of every unsheltered structure of human art. The strongest houses were caused to vibrate from their foundations; and the surface of the very earth trembled as the destroyer raged over it. No thunder was any time distinctly heard. The horrible roar and yelling of the wind; the noise of the ocean, whose frightful waves threatened the town with the destruction of all that the other elements might spare; the clattering of tiles, the falling of roofs and walls, and the combination of a thousand other sounds, formed a hideous and appalling din.

"After 5 A.M. the storm abated; at 6 the wind was at south; at 7 south-east; at 8 east-south-east; and at 9 the weather was clear.

"The view from the summit of the cathedral tower, a few hours later, was frightfully grand. The whole face of the country was laid waste; no sign of vegetation was apparent, except here and there small patches of sickly green. The surface of the ground appeared as if fire had run through the land, scorching and burning up the productions of the earth. The few remaining trees, stripped of their boughs and foliage, wore a cold and wintry aspect; and the numerous seats in the environs of Bridgetown, formerly concealed among thick groves, were now exposed and in ruins." †

It was reported that earthquake shocks were felt during this

* It is evident that the coincidence of the storm on this occasion with the day on which the earth is known to pass through the August belt of meteors, rendered the effect of this great storm at Barbadoes more striking. It is not safe to assert that there was no relation between the phenomena.

† Reid's Law of Storms, p. 28, et seq.

great storm, but the accounts seem not to have been sufficiently clear to justify the statement. Of the electrical state of the air there is no doubt, but observations on earth magnetism were not then understood or thought of in the island. It is said that heavy showers of salt water occurred.

In both the accounts here given, and in all the recorded accounts of hurricanes in the northern hemisphere, the fact of the spiral motion, the extreme force, and therefore velocity of the wind in the storm, the comparatively slow motion of the whole storm in path, and the backing of wind from north by west to south, and thence by east to north, are facts made perfectly clear. It has often happened that ships at a distance of twenty or thirty miles from the storm, and not in the line of its path, have failed to notice anything extraordinary in the weather; and on land the storm has sometimes swept through a forest, throwing down trees in various directions in its path, but injuring nothing on either side. This has been noticed in England as well as in the tropics, and is indeed a familiar fact.

The coincidence of earthquake shocks with hurricanes may be only accidental, but as it is certain that both events are frequently, if not always, accompanied by electrical and magnetic disturbances, and that earthquakes are almost always indicated by barometric changes, it would be unsafe and unphilosophical to deny that the earthquake and the storm are without mutual connection. It is not indeed easy to explain how or why this is the case; but the fact being determined by observation the theory will soon adapt itself. Earthquake shocks have also been often accompanied by falls of meteoric stones, and these again very frequently by storms and hurricanes. The earthquake shocks have usually been recorded as near the central axis of the storm, and also near the time of its commencement. It is only of late that observations of earth magnetism have been made and recorded; but it is now well known that the telegraph wires, especially those nearly meridional (proceeding from the north to the south), are altogether unusable for signals during great storms, owing to the surcharge of magnetic electricity passing through them in the form of earth currents.

Lastly, the great sea-wave that is produced by the sudden alteration of atmospheric pressure in the central part of a tornado (amounting sometimes to one-tenth of the whole pressure), multiplied as all such waves are when they enter narrow funnel-shaped channels, is at once an illustration of the nature of the storm and the cause of some of its most fatal results. This wave approaching the land rises and rushes over the surface, sometimes rising twenty or thirty feet or more above the ordinary sea-level, and in its forward and return motion sweeps

away almost everything that is not attached in the most solid manner to the earth. It is rarely (perhaps never) absent from a great hurricane; but the amount of destruction it causes is dependent on the mode in which it obtains access to the land, and the form of the land it comes in contact with.

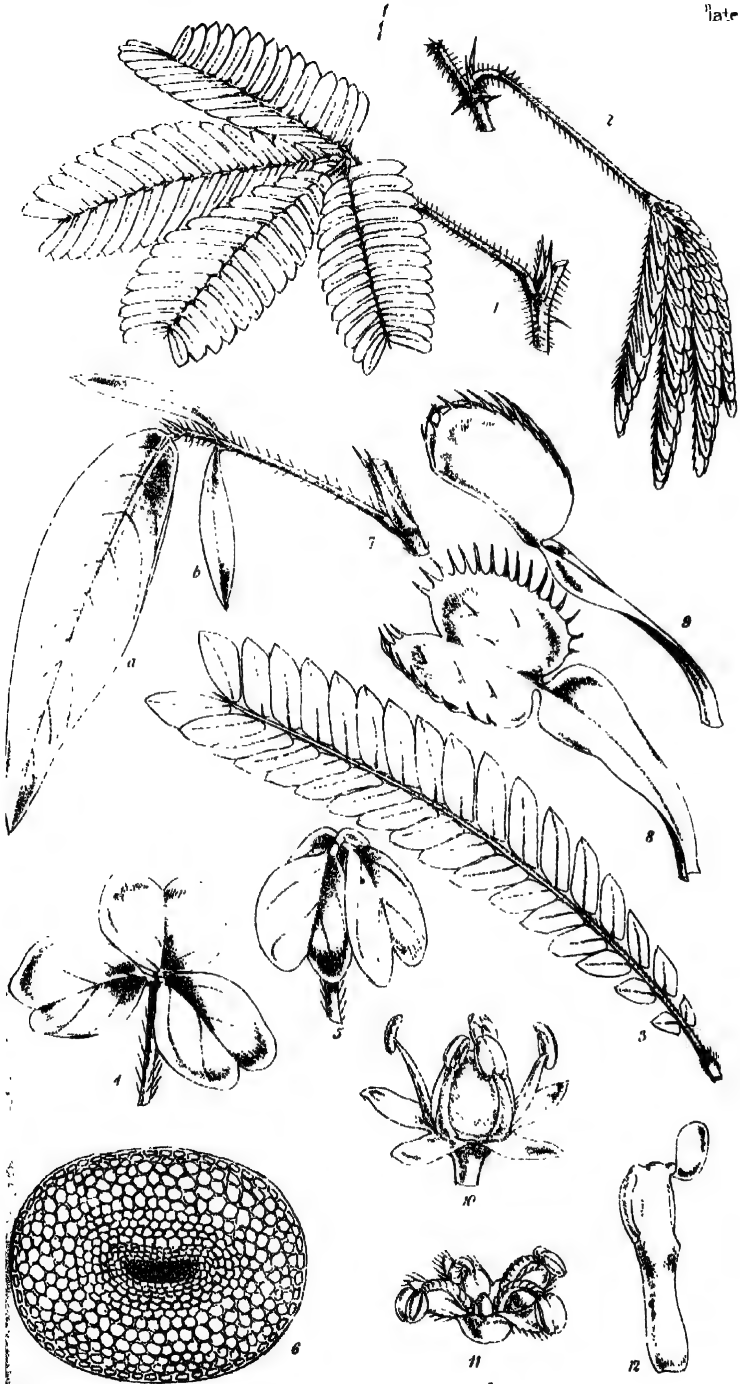
Great tropical storms are thus not mere accidents: they are like most natural phenomena—simple results of certain great laws that may be studied and understood. They occur periodically; they are intimately connected with other phenomena with which at first they seem to have no relation; they are preceded by certain indications or appearances; and they are followed by certain results. The forces that are in action to produce ordinary winds tend from time to time to produce these storms also; and should certain changes take place in the distribution of the land near the part of the world where they originate, there can be no doubt that corresponding changes would take place in the time and path of the tornadoes. Like all those phenomena which must be regarded as occasional they excite surprise, and when their effects injure human life or property we call them terrible; but they are in no sense interruptions to the established order of things, and they involve no special interference with the ordinary course of nature. In the sense in which all natural events, such as the daily rising and setting of the sun, the annual course of the seasons, or the monthly phases of the moon, are providential and illustrate the design and intelligence of a Creative Power; so must the hurricane, in its wildest and most frightful horrors, be regarded no doubt as indicating the finger of God. But it is so in no other sense. It is not a special visitation, in the sense of involving a special exercise of Divine will; for it is one of the modes by which equilibrium is restored upon the earth's surface, and is the result of a very simple modification of force essentially belonging to the established order of creation. Since the earth has existed there have been such storms; since the land existed in its present position they have taken their present course; and as these events long preceded the advent of the human race, it follows that they are neither sent to clear the air of cholera, to sweep away wicked men from the earth, nor to act as warnings to the indifferent and careless among the survivors. The human sufferings and losses that arise from them may indeed be foreseen, and if descried may be prevented. Every one interested in navigation knows well that the West Indian Islands have always been subjected to hurricanes; that the island and harbour of St. Thomas, known to be unhealthy at certain seasons, lie in the direct path of the tornadoes—few years passing without some injury from them. But the station possesses certain conveniences which it is to be presumed counterbalance this risk.

It seems as unreasonable to complain and be astonished, when a serious accident from storm occurs in such a spot, as it is for the capitalist who invests in a speculative security at a high rate of interest to feel aggrieved when his security is found to be somewhat unsound. The speculator must be presumed in each case to have estimated the risk, and acted accordingly. We venture to offer these remarks, not to check the liberality of those who, after a disaster of this or any other kind, do their utmost to sympathise with and help innocent sufferers, but simply to show the real state of the case. The hurricane that swept over the harbour of St. Thomas and the adjacent island of Tortola was not in any sense an extraordinary phenomenon. It was one of a class foreknown, foreseen, and certain to happen at one time or other. The risk might have been calculated in any required terms; and as far as the West India Mail Steamboat Company were concerned, it appears that their Insurance fund provided for their loss in ships and money. Unfortunately, although we may insure human life for the benefit of the survivors, we cannot replace the life sacrificed—and life being lost, money cannot pay for it. Thus there is a sad and painful feature in these events, admitting of no comfort; and naturally enough the human part of the question is so prominent in the eye of human beings that they are apt to forget or ignore the greater cosmical question which is also involved.

SENSITIVE PLANTS.

By MAXWELL T. MASTERS, M.D., F.L.S.

ANATOMISTS and physiologists, both alike interested in studying the manifestations of life, the one studying the working, the other the organisation of the machine, have naturally turned their attention to the vegetable world, in the hopes that the simpler structure of plants would yield a clue towards the deciphering of many a problem in animal physiology. The physiologist, by the careful observation and comparison of the several organs in various groups, from the highest to the lowest, has been enabled to make great strides towards a right understanding both of structure and function. The machine has been pulled to pieces, and its action has to a great extent been elucidated. What more natural than to suppose that a similar process carried on in the case of plants would lead to analogous results; and yet the present state of vegetable physiology is often said to bear unfavourable contrast to that of the animal kingdom. It can hardly be said that the vegetable physiologists are less active than their colleagues, or that their means and appliances are inferior. What, then, is the reason for the alleged greater proportionate advance of the one than of the other department of the history of life? The main reason, as has been often pointed out, is the comparative simplicity of plant structure as compared with that of animals. It is comparatively easy in the case of the latter to assign a particular use to a certain organ having a certain structure, or occupying a definite position. All this is a matter of easy observation; but in the case of plants we find organs, to all appearance, essentially the same as to structure performing widely different functions. If a student of the animal kingdom saw the same organ performing at one time the functions of absorption, of exhalation, and of secretion, he would be as much embarrassed as a botanist is when he comes to investigate the functions of the leaf. And after all, when the matter comes to be sifted down, there is no such great difference between animal and vegetable physiology as to their relative status. In the presence of the cell, simple enough in its structure, but widely diverse in its mode of action in different cases, the physiologist, whatever



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branch of the science he may study, stands abashed. Watch the passage of fluids from one cell to another; nay more, strip off the outer coating of the cell—the cell-wall—and leave the little dab of slime, as it has somewhat contemptuously been called, and watch its sometimes active movements; see it contract and expand, observe the chemical changes that take place in it. Where now is the difference between the animal and vegetable physiologist? Is the one better able than the other to cry "Eureka, this is the mystery?" Can the one float better than the other in the sea of knowledge, or are they not both equally at fault? Nevertheless, the experience of the last few years has shown that the investigation of these humble cells and their doings is, in all probability, the one path by which the physiologist has to travel in order to unravel as much of the mysteries of life as it may ever be granted to man to solve.

Motion among animals implies a muscular apparatus of some sort or other; it implies a sensibility to external impressions, and, at any rate in the higher groups, a greater or less degree of volition, and as a consequence a nervous system. In the case of plants, there is motion of various kinds; there is evident sensibility to external impressions; and there is evidently a power of transmitting impressions from one part to another. But, so far as structure is concerned, there is no muscular system—no nervous system, at least in the sense in which those terms are usually employed. The lowest animals, those debateable creatures concerning whose nationality such contests have been waged, are no better off. Where is their muscular system? Where are their nerves? And yet they move, they show a repugnance to noxious agents, they are evidently in a degree sensitive. Clearly then, the essential attributes of both muscular and sentient structure are to be sought among these humble organisms, plants or animals, it is indifferent in which division they are placed. And, as has been before said, there is no room for glorification on the part of one naturalist over another. Both are alike ignorant. Travelling by two different roads, they have come to the same point, picked up much information on the way; so much that neither the one nor the other have the least doubt of accumulating a great deal more in due season.

In the present article we hope to be able to present to the reader a sketch of what is known as to the movements exercised by plants, and specially by those usually termed "sensitive plants." And here it may be remarked, that the actual movements exhibited by sensitive plants are not materially different, except in degree, from those more general movements which, from being always under our eyes, attract less attention than they would were they only occasionally visible. For instance, the elevation and depression of leaves according as they are

"awake or asleep," phenomena obvious enough in many plants; the folding and unfolding of flowers; the movements shown by tendrils and climbing plants, to which Mr. Darwin has recently drawn so much attention, and a summary of whose researches, from the pen of the Rev. George Henslow, appeared in the pages of this *Review* last year. These, together with the movements observed in the stamens and pistil, in connexion with the fertilisation of the latter organ, are probably, if not certainly, effected by similar means, even though those means be called into action by different circumstances. Allusion may here also be made to the movements observed in the branches of trees in frosty weather. In the Report of the Proceedings of the Botanical Congress, London 1866, is an elaborate paper by Professor Caspary, showing the effect of cold in inducing these movements, the direction of which varies in different trees, and the amount of which is generally in direct proportion to the intensity of the cold. Dr. Caspary, however, has not been able to ascertain how the cold produces these actions. Motion by the action of ciliæ—as marvellous a phenomenon as any—appears to be confined to the simplest organisms in the plant world, which do not come strictly within the limits of this communication. But inasmuch as it has a relation to other facts, to be hereafter alluded to, we may call attention to the action of light on these lowly creatures. Dr. Ferdinand Cohn, amongst others, has clearly shown that the direction in which these plant cells move is influenced by the direction in which the light falls. They move towards the light, turning their ciliated ends towards it, while the remainder of the cell which, unlike the part just mentioned, is filled with chlorophyll, is directed away from the light. If the rays be prevented access no movement at all takes place, and while the red and the calorific parts of the spectrum generally have no effect, the blue and violet rays are specially powerful in producing the effect. The motions shown by the *Oscillatoriæ* can hardly be passed without mention, though in truth little is known concerning them. The plants just named are simply cylindrical cellular tubes, endowed with a peculiar undulatory movement which is exerted by the gelatinous contents of the cell, rather than by the cell wall. So much is made out, and it is of great significance, as showing that, as is the case with almost all the other principal phenomena of life, it is the protoplasm which is the seat of activity and not the outer cell wall. This contractile power of the protoplasm is seen in no plant better than in the *Selaginella mutabilis*, now often to be met with in hot-houses. This plant, under the influence of bright light becomes of a pale whitish colour, as though milk had been spilt over it, but when the intensity of the light is less it resumes its green colour. The

microscope plainly shows that in the former condition the protoplasm is contracted into a round ball, while in the latter state the endochrome is diffused throughout the interior of the cell. No general movement of the whole frond is perceptible here, and the circumstance is merely alluded to as showing in a marked degree the contractile power of the protoplasm, and as offering grounds for the conjecture that some of the movements in plants may be attended by a like contraction. It is much to be desired that some one with the necessary leisure and appliances should institute experiments on this singular little Lycopod.

It seems clear at any rate that light has as much to do with the movements of some of the lower organisms as it has with the direction of branches of leaves and flowers. Here also we may refer to the extraordinary rhythmical tremors observed by M. Lecoq, of Clermont, in the leaves of *Colocasia esculenta.* These are stated to occur at intervals, the plant in the meantime being perfectly at rest; so violent are the vibrations, according to M. Lecoq, that on one occasion the very pot in which the plant was growing shook so violently that it could with difficulty be steadied! This statement has been confirmed by another French naturalist. It may be remarked that the emission of water from a pore near the apex of the leaf has been occasionally observed; hence it has been suggested that in the case of M. Lecoq's plants, the tremors may have been occasioned by the efforts of the plant to rid itself of the water. Certain it is that in many cases no such aperture is visible in the plant in question, and that the emission of water is not by any means a common phenomenon. We must wait for fuller details before it can be decided whether the perforate or imperforate condition of the leaves has anything to do with the actions in question. Prof. Lecoq is too well known as an acute observer to allow of his statements being questioned on light grounds.

Adverting now to "sensitive plants," specially so called, apparently from the fact that the movements they exert may be set in action by mechanical agency, as by a touch with the finger or other object, by a breath of wind, &c., it may be remarked that the numbers possessing this property are much larger than is usually supposed.

Leguminosæ and *Oxalidaceæ* afford the greatest number of such plants, and they have this in common, that the mobile leaves are "compound," consist not of one piece, but of several secondary leaflets, jointed to a common stalk, the "joint" being evidently the part most concerned in the movements that take place. *Mimosa pudica* and *M. sensitiva* are the two "sensitive plants" most commonly grown in this country. In either, a slight touch upon the extremity of one leaflet causes the depression of that leaflet, then of its neighbour, and so on in succession till,

according to the force of the blow, the whole series become folded together, the secondary leafstalks fold together like the ribs of a fan, and the common stalk drops by the side of the stem. After an interval, the plant recovers its equilibrium, and the original position of the leaf is restored. Similar movements occur at night, constituting "the sleep" of the plant. Some of the tropical species of *Oxalis* show similar phenomena. Unlike our common Oxalis (*O. Acetosella*), the plants in question have long pinnate leaves similar to those of the *Mimosa pudica*, and at the least irritation they close their leaflets as in the last named plant; in some instances, however, raising the leaflets instead of depressing them. By the older botanical writers the Oxalis was known as the "Herba sentiens;" and Rumphius, who gives a full description, as well as a figure of it, expresses his surprise that in Amboyna the plant should be so often found in exposed places, where it would seem most likely to be exposed to violence, adding, somewhat facetiously, that it is like a young lady who wishes to be looked at, but not to be touched!

One quality was attributed to the Oxalis which, did it really possess such, would render the services of the "Professors" who undertake the delineation of character from an inspection of the handwriting superfluous. So chaste was the plant that its leaves collapsed in the presence of vice, and hence it was made, so runs the tale, to serve as a sort of test, to eliminate the good from the bad, to act as a love-philtre, and even to expurgate the guilty and render them as free from taint as itself. It is a pity the herb should have lost its virtues in these days!

This *Oxalis sensitiva*, probably in its native country the most amenable of all plants to external influences, is in this country quite, or nearly quite, destitute of the power of closing its leaflets when irritated; a circumstance that should not be overlooked when casting about for the causes of the phenomenon. Our common wood-sorrel has the power of depressing its leaflets at night and of raising them in the day; but does not seem to be sensitive to mechanical stimuli.

The Fly-trap *Dionæa* is another of the best known of the sensitive plants. It is closely allied to our Sun-dews, *Drosera*, the leaves of which are also said to be endowed with a certain sensitiveness—so feeble, however, that but few have ever seen it. In the *Dionæa* the upper half of the leaf folds in halves, like a sheet of note paper when an insect happens to touch one or more of the hairs which beset its surface. A "chevaux-de-frise" of bristly points surrounds the margin of the leaf, so that the unlucky insect remains a prisoner till it dies. What possible object the plant has in thus catching flies, or what is the real purport of the peculiar movement, no one knows, though, as may be supposed, speculation of the wildest character has been indulged in concerning it.

One more illustration—perhaps the most extraordinary of all —is afforded by the Telegraph plant, *Desmodium gyrans*, a native of India. The leaves of this plant consist of three leaflets—two small lateral ones, and a third, much larger, terminal one. If the Desmodium be watched, the terminal leaflet may be observed to move upwards or downwards, according to the intensity of the light; the lateral leaflets having a still more vigorous and perfectly independent action, recalling that of the old Semaphore signals, and one which is going on day and night alike, and hence is unaffected by the light. The action of these smaller leaflets is so singular as to demand a more exact description than is called for in the other instances. Supposing one of the smaller leaflets to be in the horizontal plane, if watched it may be seen to rise by a succession of little jerks, keeping its point and upper surface directed towards the stem. When it has attained a nearly vertical direction its companion leaflet begins to descend, turning its upper surface away from the stem as it falls. Having descended to the horizontal position, the other leaflet begins to rise again, and so on. Electrical and mechanical stimuli appear to have no effect on these movements, though heat and moisture accelerate them. They are perfectly perceptible in our stoves; but less so than under natural circumstances. These motions are, perhaps, the most mysterious of any, and, though much has been written concerning them, we know little more than when they were first brought under the notice of the scientific world by Lady Monson, in the latter part of the last century.

The phenomena that take place in the flower are not less worthy of observation than those of the stem and leaves. The folding and unfolding of the flowers, sometimes at regular hours, did not escape the observant Linnæus, since whose time, indeed, but little addition has been made to our knowledge of this branch of the subject; but it is one that sadly requires fuller investigation. How is it, for instance, that the Sidas of India expand their flowers in the morning only, while the Abutilons, which scarcely differ from them in any point of structure, yet unfold their blossoms in the evening only. The movements that take place in the stamens and pistils have, however, attracted more general attention, because in many cases the mobility is excited by mechanical stimulus; a slight touch with a pin or the antenna of an insect will suffice to cause the stamen of *Berberis* to bend suddenly inwards towards the stigma, there to deposit its pollen. But the mere enumeration even of the many instances of mobility in connection with the dispersal of pollen or of the seed would occupy more space than we can give to the subject, and so we pass on to the anatomy of the mobile organs. We cannot, of course, give the details in every case where motion has been observed, but we may state in general terms that it has been

well ascertained that the mobile property resides in the cellular tissue *par excellence*, and is not primarily, at least, manifested by the woody or by the vascular tissues, though these may serve to transmit the impressions from one part to another. This holds good in the parts of the flower as in the leaves. It may be as well, however, to describe the general structure of the little swelling (*coussinet* of the French) that is so generally found at the bas of the leaflets, and also of the leaf in those cases where they are endowed with the greatest mobility, merely stating that the presence of the "coussinet" does not always accompany the property of raising or depressing the leaf. The structure of the coussinets is readily made out, by an examination of transverse or longitudinal sections, from which it may be seen that there is in the centre a small quantity of pith cells surrounded by a ring of fibro-vascular tissue; longitudinal slices show that this ring is formed by the coalescence of groups or bundles of vessels which in the leaf-stalks are separate. Outside the fibro-vascular ring are three or four layers of cells—the inner ones containing starch grains, the outer ones chlorophyll; they are comparatively loosely aggregated, so that small spaces are left here and there between them. Next in order from within outwards is a much thicker layer of cells, so closely packed as to present no intercellular spaces, and which are filled with chlorophyll, and frequently with some powerfully refracting substance of an oleaginous nature; investing this thick cellular layer is the ordinary epidermis, destitute of stomata. Similar structural arrangements exist in all the "sensitive plants" yet examined. Now, as to the action of these layers of tissue, Sachs*—many of whose experiments we have repeated—has shown that, if thin transverse slices of the coussinet be thrown into water, the thick outer layer of cells, in which there are no intercellular spaces, becomes distended and turgid; and when a longitudinal section is made, as the outer cells are fixed, on the one hand to the epidermis, and on the other to the central tissues and to the vascular ring. the two ends of the section become bent, while the central portion, being fixed, remains comparatively unaffected. If the slice be bisected there will be a double curvature, the portion attached to the epidermis curving in one direction, that fixed to the central bundle bending in the opposite direction, the concavity of the curve in either case being necessarily on the same side as the point of attachment. It would appear that the turgescence of the cells in this case is due to endomose, as when the sections are placed in sugar and water the direction of the curves is reversed.

Experiments of a like nature were made many years since by

* Bot. Zeitung, 1867.

Dr. Golding Bird, who showed that the curvature which takes place when the stalks of herbaceous plants are divided vertically is due to osmotic action. Similar phenomena were observed by Morren in the mobile styles of *Goldfussia* and *Stylidium*. As regards the sensitive plant, it has been shown by isolating the cellular from the fibro-vascular portions, by means of incisions, above, below, and to either side of the central cord, that the cellular tissue so liberated becomes lengthened; hence, all the while it remained attached to the central cord it must have acted like a spring, or rather as a double spring, one on one side, one on the other. When the force exerted by the one equals that of the other the leaf is retained in the horizontal position, but if the equilibrium be destroyed, the leaf falls. This equilibrium may be destroyed either by the superior energy of the upper spring, or by the diminished force or temporary paralysis of the lower one, owing to which the upper spring is able to push down the leaf and keep it down till a renewal of force in the lower cells replaces the leaf in its natural position. This latter explanation is the one that is generally accepted by physiologists.

Anatomy, then, points to the rush of liquids from certain cells, and to the turgescence of others, as the cause of the movements, equilibrium being restored when the fluids again become diffused. Assuming that this unequal distension of certain cells is at least a general concomitant with the motions in question, it remains now to trace the causes that set them in action. Some of these, such as light, especially the blue rays, and heat have been already alluded to; but we have still to allude to the effect of what may be termed mechanical stimuli, including in that term agents that act chemically. Sensitive plants have been subjected to almost as many experiments as rabbits or frogs. A volume would be required to give the details; all that it is necessary to do in this place is to state the general results. The effects of contact with the finger or other object, the result of a puff of wind or a drop of water, on sensitive plants are well known. Touch them, and they shrink from the blow by whatever means it be inflicted. Vibration, even without actual contact, is sufficient to set the leaves in motion. A footstep in their native country makes the leaves close; in other cases, as we have seen, the touch of an insect ensures the motion of the leaf or of the stamen. Sensitive plants, however, are apt, like other creatures to get more or less accustomed to external influences, to get exhausted, and so after a time become indifferent and lose their mobility. A curious instance of this is seen in the experiments performed by Desfontaines, who carried a Mimosa about with him in his carriage. The poor plant at first manifested its usual signs of sensibility, but by-and-by it ceased to respond to the stimulus, and its leaves became motionless.

We can testify to similar results, from conveying a specimen by railway. The circumstance that most of the sensitive plants are more active in their native country than with us has been already alluded to, and we may add, as a fact of equal significance, that towards the close of the year when the *Mimosa pudica* (an annual) loses its leaves and ultimately dies, the sensibility to external impressions is much more feeble than when the plant is in full vigour.

Opium, ether, chloroform, all exert a paralysing influence on the leaves. Strong acids and other caustic substances, on the other hand, induce contraction at once. With reference to the action of ether, we may relate the result of some trials that we have recently made with that fluid. On allowing a drop to fall on one of the leaflets of *Mimosa pudica* from a height of five or six inches, contraction of the leaflet instantly took place, and was immediately followed by the motion in successive order of the adjacent folioles proceeding from the apex towards the stalk of the leaf. When, on the other hand, the drop of ether was placed as gently as possible on the surface, the leaflet did not move, but seemed paralysed by the anæsthetic agent, while the adjacent ones not touched by the ether moved as in the preceding case. Ether-spray applied with the jet had precisely similar effect. When the spray fell directly on the leaflets, that is with some force, the impact of the falling drops counteracted any paralysing power that the ether might have; but when the spray was so directed as not to fall directly or with force on the leaflets, then such of them as came within its influence were rendered motionless, the adjacent folioles contracting from the distal towards the proximal end of the leaf as before. A spray of water directed on to the leaflets caused them to fall, but if not allowed to impinge directly on them no motion ensued, though of course the water did not, as the ether did, stop their mobility, as a touch was sufficient to make them collapse after the water-spray, while after the ether-spray contact produced no effect.

The effect of the ether-spray on certain other plants was, in two instances, so remarkable that a record may here be given, though it must also be borne in mind that the results now to be mentioned were only obtained in two instances out of many trials on various plants in hot-houses, in the end of November of the past year (1867). On applying the spray to the extremity of one leaf of *Iresine Herbstii*, which from having been grown in heat was what gardeners call "drawn," that is, had comparatively long intervals between the leaves, and a flaccid texture, a thin film of ice was speedily produced on the distal end of the leaf. In less than two minutes the whole shoot, four to five inches long, was observed to bend quickly downwards, forming as it did so a curve whose concavity was downwards. Next morning the whole shoot was dead. To what precise circumstances this rapid trans-

mission of the effect from one end of the shoot to the other, and its ultimate death, are due, it would be premature to assert, as it is difficult in such a case to eliminate the irritant effect of the ether (clearly it did not here act as an anæsthetic) from the effect of the cold and ice produced by its rapid evaporation. It may here be stated, that two or three drops placed on the leaf in the ordinary way had no effect at all. A few days after, similar trials were made in the Botanic Garden, Chelsea, on some plants of the same species, grown in a colder house, and which were "shorter jointed" and altogether firmer in texture. In these instances no other effect was produced than the death of the leaf. The other case to which allusion may be made was a *Maranta*, also growing in a stove, and in which the application of ether-spray to the tip of a leaf caused it to roll up on to the under side like a roll of paper. In the young state the leaves of this plant are rolled lengthwise (convolute), but the effect of the ether was to cause the leaf to roll up along the under surface from the tip towards the stalk. Similar experiments were tried on other Marantas, but without effect.

Now, though of course little stress can be laid on these experiments, they appear to be worth recording, as suggesting other trials at a more favourable season—trials from which possibly something may be learnt as to the movements of plants, the propagation of impressions, the action of irritants, or of frost.

So suggestive a matter has not been lost sight of by the students of electricity; the results, however, of electrical experiments are somewhat conflicting. Some months since, Dr. Sigerson, who was corroborated in his statements by Dr. Divers, stated that the leaves of the sensitive plant when touched with glass (a non-conductor) failed to exhibit their customary sensibility, but if touched with steel or other good conductor the usual results were at once manifested. Dr. Sigerson even stated that he felt a painful sensation in the ulnar nerve at the right elbow (the funny-bone) after having touched with the little finger of the same side the leaf of the *Dionæa*. On repeating these experiments ourselves on several occasions we have not seen any difference in the effect of glass or other substance used to touch the leaflets. Mr. Hamilton, writing from Grey Town, Nicaragua,* where the *Mimosa* grows wild, also repeated these experiments without the results seen by Dr. Sigerson, but he confirms the opinion expressed by that gentleman that children affect the plant's movements more than adults do. Dr. Sigerson even hints that the movements are more active when excited by a person in a "tonic" condition than when he is weary or exhausted. M. Blondeau, one of the most

* Gard. Chron. 1867, p. 31. (Extract from the Athenæum.)

recent experimenters, and the account of whose researches is given in the *Comptes Rendus* for the present year, found that when a current from a galvanic battery was passed through the leaves, no result was produced and that the plant did not respond to the stimulus. On the other hand, when in place of the direct an indirect current was employed, by the use of a small Ruhmkorff's coil, the results were entirely different—the leaflets folded up and the leafstalks drooped along the whole course of the stem. If the current were continued for a short time the plant after a period of repose raised its leaves and resumed its ordinary state; but if the experiment were prolonged for twenty-five minutes the organism seemed to become entirely exhausted, and the following day was found withered and blackened, as though struck by lightning, and the same effect has been noticed by M. Bert. Still more remarkable were the effects noticed when the plant was allowed to come in contact with the vapour of ether. Induction currents of electricity have little or no effect on animals when under the influence of anæsthetic agents. In order to see what would be the effect in the case of the *Mimosa*, under like circumstances, M. Blondeau exposed a specimen to the anæsthetic effect of a few drops of ether sprinkled in the glass enclosing the plant. In a short time, says M. Blondeau, the plant experienced the effect of the anæsthetic—its leaves refused to move when shaken, and manifested no sensibility even when the induction current was passed through them.

From what has been stated it will be evident that we have yet much to learn as to the causes of the movements observable in the vegetable world. Different plants act differently under the same circumstances, as in De Candolle's experiments with artificial light. The *Mimosa* and the *Oxalis* so treated gave opposite results. So, too, the same plant at various times and under diverse conditions acts differently. In no other way can we account for the discrepancies in the results of experiments conducted by men of equal ability and competence. It is probable that some of these discrepancies may arise from the confounding the movements that constitute the so-called sleep of plants with those that take place in consequence of some external stimulus. This seems the more likely from a consideration of the researches recently made public by M. Paul Bert.* We regret that our space does not permit us to allude at length to M. Bert's elaborate paper, but we may, by way of conclusion,

* M. Bert's paper only reached us while this sheet was passing through the press. It is contained in the 4th volume of the *Mémoires de la Société des Sciences Physiques et Naturelles de Bordeaux*, and is dated April, 1867, the title-page of the "cahier" in which the paper appears bearing the date 1866! It is one of the most important memoirs on the subject of the Sensitive plant that has yet been issued, and should be consulted by all interested in the matter.

state the result of his experiments relating to the difference between the two classes of phenomena above mentioned. After describing, with greater accuracy and detail than any previous writer, the diurnal and nocturnal movements that occur in the leaves and leaflets of the *Mimosa pudica*, and showing that they do not differ, in appearance, from those which ensue as a consequence of external stimulus, except that in the latter case the action is sudden not gradual, M. Bert proceeds to say that the causes of the phenomena are not the same in both instances.. Ether arrests and prevents the movements brought about under ordinary circumstances by external stimuli, while the diurnal and nocturnal raising and lowering of the leaves are not affected by that agent. The last named actions may be induced artificially by removing the upper portion of the petiolar "coussinet," and then placing on the cut surface a drop of water; this is rapidly absorbed by the cellular tissue of the lower portion of the swelling, and the leaf-stalk becomes raised or pressed upwards in consequence. On the other hand, if a drop of glycerin be placed on the wound, the reverse action takes place and the petiole is lowered. The nocturnal movements are always caused by a slow gradual increase of force in the upper portion of the coussinet, accompanied at first by a diminished, subsequently by augmented, energy in the lower portion. The mobility that follows on excitation, on the other hand, is exclusively due to a sudden loss of energy in the lower portion of the petiolar swelling, though how this is effected remains still a mystery.

EXPLANATION OF PLATE.

FIG. 1. Leaf of *Mimosa pudica*, common Sensitive plant, expanded.
" 2. Leaf of the same collapsed.
" 3. Leaf of *Oxalis sensitiva*, expanded.
" 4. Leaf of *Oxalis acetosella*, Wood-sorrel, expanded.
" 5. Leaf of the same collapsed during "sleep."
" 6. Transverse section of the "coussinet," or pulvinus of *Oxalis acetosella* (after Sachs).
" 7. Leaf of *Desmodium gyrans*, Telegraph plant: *a*, the terminal leaflet: *b*, one of the lateral leaflets, which exhibits different movements from those exercised by *a*.
" 8. Leaf of *Dionæa muscipula*, Fly-trap; the leaf-stalk is here dilated and flat, and supports a roundish blade, fringed with stiff hairs.
" 9. Leaf of Fly-trap; the blade shown as folded in halves.
" 10. Stamens of *Parnassia*, showing how they bend inwards towards the pistil.
" 11. Stamens of *Parietaria* at first coiled up within the flower, but liberating themselves with an elastic movement when the pollen is ripe.
" 12. Stamen of *Berberis*, showing the flap of the anther which springs up to liberate the pollen.

THE FORMER RANGE OF THE REINDEER IN EUROPE.

By W. BOYD DAWKINS, M.A., F.R.S., F.G.S.

THE Reindeer is the only member of the great genus Cervus fitted by nature to endure the extreme severity of an arctic winter. It thrives on the mosses that cover the great treeless spaces extending between the boundary of the woods and the great arctic sea, in Northern Europe, Asia and America, which it seems to prefer to the more tender herbage further to the south. It is found also at the extreme edge of the woods both in Asia and America, and retreats to their recesses to find some sort of shelter and food during the depth of the winter. South of its habitat lies the region of the elk and the red-deer, the exact boundary being regulated according to the season. Thus in an unusually warm summer the two latter animals advance northwards into the country of the reindeer, while in an unusually severe winter the reindeer passes southwards in search of food, as Sir John Franklin found out to his cost in his overland journey from the great arctic ocean. In this way the boundary is continually oscillating to and fro. The reindeer has been met with in the highest northern latitudes yet reached by our explorers. It abounds in Greenland and Spitzbergen, and has even crossed over on the ice to the cluster of islands off the Siberian coast, called New Siberia. In the highlands of Norway and Sweden it is also found, as well as in the loftier regions of the Urals.* Such is its present range. In past time, however, it wandered over a vast area far to the south and west of its present abode; what that range was and the causes of its modification are subjects well worthy of research, on account of the light they throw on European climate in former days. It has indeed been objected, that although climate exercises a great influence in modifying range it does not exert the only influence, and therefore that any argument from one to the other is faulty. The Bengal tiger is of the same species as that which preys on the Tartar horses on the shores of the Caspian, and on the reindeer of Eastern Asia. The fox and the wolf are also, as

* Pennant, Arctic Zoology, vol. i. p. 24.

Cuvier remarked, adapted for enduring any climate; it is clear, therefore, that you could not infer climate in past time from the presence of any of these animals. This objection is indeed partly true: the carnivora can live wherever they can obtain their prey, climate being of secondary importance; but the food of the herbivores is *directly* dependant upon climate, and as vegetation is divided into regular zones, according to the temperature in each, so the herbivores are also divided, each species being fitted best to live on the food which surrounds it, while the carnivores can thrive in any of the zones. We can therefore reasonably infer the climate from the study of the herbivores.

We propose to trace the reindeer from its first known appearance in western and middle Europe to the present day, from the Pleistocene, through the Pre-historic, into the Historic period, and draw whatever inferences we can as to climate. The identity of the fossil with the recent reindeer first surmised by M. Guettard, in the first quarter of the present century, was proved by Professor Owen in 1834; and since that time ample materials have been accumulated for determining the former range of the animal.

The Pleistocene period in France, Germany and Britain is divisible into three great epochs; the first of these, or the Pre-glacial, is that during which the land was more highly elevated above the sea than at the present day. Britain formed part of the mainland of Europe, and the character of the fauna shows that the climate was, to say the least, temperate. This latter condition was probably the cause of the non-existence of the reindeer in Pre-glacial Europe; although according to the views lately put forth by Professor Brandt of St. Petersburgh, it was living at the time in the colder climate of Northern Asia. Then the land was depressed, and hill and valley alike sank beneath the waves of the sea; the temperature also was lowered, so that glaciers flowed down the hills of Cumbria, Wales, and Scotland, and all the high mountains of Europe; and icebergs deposited their load of sand, mud, and fragments of rock throughout the greater part of Russia, the lowlands of Germany, and the centre of England. Whether this change of temperature was gradual or not is an open question, and probably must ever remain so. Had it, however, taken place before the depression of the land, the reindeer would most certainly have been found in pre-glacial or glacial deposits; for as there are no geographical barriers in the way, the arctic group of animals dwelling in Siberia would have migrated into Europe as the conditions of life became more and more suitable for them. There is not, however, the slightest trace of any of them in any deposit which is undoubtedly pre-glacial or glacial, and therefore the inference may be drawn that before the lowering of the temperature in Central Europe the

sea had already rolled through the low country of Russia, from the Caspian to the White Sea and Baltic, and formed a barrier to the western migration of the arctic mammals of Asia, when arctic conditions favourable for their living were found in the higher parts of Europe which were not submerged. Subsequent to this great glacial epoch the land gradually rose, Britain again formed part of the continent, and a path was opened for the immigration of the arctic animals into Germany, France, Britain, and Ireland.

The reindeer makes its first appearance in Western Europe in caverns and river gravels and sands of post-glacial age. Its abundance in British deposits of this date has been altogether overlooked up to the present day. In the cavern of Kirkdale* its antlers have been described by Dr. Buckland as those of a small deer; their gnawed condition proves that the animal fell a prey to the great cave hyæna. Strangely enough, in the same cavern were obtained teeth of the hippopotamus, so that we have two animals associated together, the one confined at the present day to an arctic region, the other belonging to a genus that now ranges through the length and breadth of Africa. In Kent's Hole, also, the same two animals were found by the Rev. W. MacEnery. In Wookey Hole Hyæna-den it occurs along with the remains of man and those of the Leptorhine and Tichorhine rhinoceros, the cave lion, cave bear, mammoth and red-deer. In other caverns also in the south of England it is very abundant—at Banwell in association with the leopard and otter, in Brixham with the grizzly bear and roe-deer, in Hutton with the Irish elk, at Uphill with the wild boar, at Oreston (which furnished Professor Owen with the first proof of the existence of the animal in bone-caverns) with the great urus, at Berryhead with the pole-cat. In Wales also it is most abundant in the caverns of Pembrokeshire—in Paviland with the wolf, and in Gower with the leptorhine rhinoceros and man. It is indeed so abundant in Britain that it occurs in no less than thirteen out of twenty-one caverns, the contents of which have passed through the hands of the writer, while the red-deer has only been found in seven; thus, contrary to what is generally assumed to be the case, the former animal predominated over the latter in numbers at the time the British bone-caverns were being filled.

If we pass from the caverns to the examination of the post-glacial river deposits we shall find the same numerical preponderance of the reindeer. It has been found by Mr. Trimmer along with the cave bear, *Elephas antiquus*, and leptorhine rhinoceros. in the gravels of Brentford; by Mr. Leyton in a railway cutting at Kew bridge; while from a gravel bed higher up the Thames at Windsor it furnished at least one-half of the remains found

* Reliquiæ Diluvianæ, 4to., 1824.

by Captain Luard in the spring of 1867. In the gravels on which Oxford stands it is found in greatest abundance; at Bedford it is associated with flint implements, the red-deer and the hippopotamus; at Lawford, near Rugby, with the cave hyæna; at Fisherton, near Salisbury, with the cave lion, urus, roe-deer, marmot, and lemming; in Kent also it is abundant in the brick earth of Sittingbourne and Maidstone; in Somerset in the gravels of the Avon, near Bath. Altogether it has been determined in ten out of eighteen river deposits which have furnished fossil mammals, while the red-deer has been found only in nine. The remains also of the latter animal, even where they do occur, are few and scant, while those of the reindeer are so abundant that their numbers can only be accounted for on the hypothesis that vast herds adopted certain routes in their annual migrations and crossed the same rivers at the same points, just as they do at the present day in the northern regions. In Siberia, for instance, Admiral von Wrangel writes*—"The migrating body of reindeer consists of many thousands, and though they are divided into herds of two or three hundred each, yet the herds keep so near together as to form only one immense mass, which is sometimes from fifty to a hundred wersts (or thirty to sixty miles) in breadth. They always follow the same route, and in crossing the river Aniuj near Plobischtsche they choose a place where a dry valley leads down to a stream on one side, and a flat sandy shore facilitates their landing on another. As each separate herd approaches the river the deer draw more closely together, and the largest and strongest take the lead. He advances, closely followed by a few of the others, with head erect and apparently intent on examining the locality; when he has satisfied himself he enters the river, the rest of the herd crowd after him, and in a few minutes the surface is covered with them." There could not fail to be many casualties in a vast migratory body such as this, and doubtless even were the hunter, and the animals that invariably prey upon such a herd, absent, many of the weaker animals would be swept down by the current and drowned, and their bones would lie in great abundance at some points below the reindeer fords. In this way the vast quantity of the remains of reindeer accumulated at certain points in the ancient river beds, as for instance at Windsor, may be accounted for. With the exception of the horse, mammoth, and perhaps the bison, its numbers were larger in post-glacial Britain than any other animal.

* Siberia and Polar Sea. Trans. by Major Sabine, 1840; 8vo., p. 190. A werst is about two-thirds of an English statute mile. There must be some mistake in this estimate of breadth; for no observer could see a body of deer of that width in a country so full of ups and downs as that of the Aniuj. The numbers must have been incalculable.

In the post-glacial deposits of France it has been found in both caverns and fluviatile sands and gravels; the first record of its discovery is that furnished by M. Guettard from the sands underneath the town of Etampes. Baron Cuvier,* however, with his usual caution, does not absolutely determine the remains to be those of reindeer, but to a very closely-allied animal. He writes with greater certainty about those from the cavern of Breugue, which were associated with the bones of rhinoceros and horse, although he does not actually make up his mind on the point. Subsequent discoveries have put the question beyond all doubt. The animal also occurs in the cavern of Ballot, near Chatillon, sur Seine in the Côte d'Or, and the environs of Issoire, in the Puy de Dome.† The extreme southern range of the animal in post-glacial times is the Spanish side of the Pyrenees, where it has recently been discovered by M. Lartet. In Belgium it occurs in the caverns of Liege, and in Germany in that of Gailenreuth.

Recent discoveries in Central France have established the fact that towards the end of the post-glacial epoch the characteristic post-glacial mammals began to disappear. The tichorhine and leptorhine rhinoceros and the *Elephas antiquus* departed from the soil of France, and were replaced by the ibex. chamois and the antelope of the Siberian steppes (*A. Saiga*). The cave lion, however, still lingered on, and the mammoth afforded food to the hunter, and has been handed down to us in an engraving on one of its own tusks. The reindeer were so abundant at this time that the epoch has received the name of the Reindeer Period. It formed the principal food of the cave-dwellers on the banks of the Dordogne and the Vezère, who in habits and mode of life more closely resembled the Esquimaux than any other folk living on the face of the earth. Probably the post-glacial continent had been depressed before this epoch, and England insulated from the mainland, as neither the man of the period nor the chamois, ibex, or antelope have been found in our islands. Had there not been some natural barrier those animals would probably have crossed over, for in other respects the post-glacial fauna of France is identical with our own. The date therefore of our insulation would be anterior to the immigration of those animals into France. But however this may be, there is not the slightest doubt that the Reindeer period, or the last phase of the great Post-glacial epoch in France, is unrepresented on this side the channel.

We have now to discuss the range of the animal in Pre-historic times. While our estuaries were being silted up, and the alluvia

* Oss. Foss. tom iv. 4to., 1825.
† Gervais, Paléont. Franc. 4to., 1859.

at the mouth of our rivers were encroaching on the domain of the sea, and our peat bogs were being formed, the reindeer struggled for life in Britain with the red-deer. The relative numbers of these two animals in the two epochs is very significant. During the arctic severity of the post-glacial climate, the remains of the red-deer were rare, while those of the former animal were most abundant. During the Pre-historic period the red-deer gradually increased in numbers until the reindeer at last became extinct. In its rarity in the latter epoch we have proof of the great climatal change that had taken place in France and Britain. It has, indeed, been found only in some eight or nine places in the United Kingdom. Professor Owen figures, in his *British Fossil Mammals*, fig. 197, a skull with antlers from a subturbary deposit in Bilney Moor, near East Dereham, in Norfolk. He also gives a figure of a metatarsal bone in the fens of Cambridgeshire. A third case was afforded during the excavation at Crossness Point, on the south side of the Thames, near Erith, which was made for the reservoir of the southern outfall of the metropolitan sewage. A fine antler was obtained from the bottom of a layer of peat varying from five to fifteen feet in thickness, along with the remains of beaver and a human skull. This is the only instance that has come before my notice of the association of reindeer with man in any British pre-historic deposit. A tracing of an antler sent me by Mr. Tiddiman, of the Geological Survey of Great Britain, brings the number of cases of its occurrence in England up to four. The original was found in a shell marl underlying the peat near Whittington Hall, in Lancashire. Nor was it more abundant in Scotland. In 1775 some antlers were bound by Dr. Ramsey,* Professor of Natural History in Edinburgh. In 1833 antlers also were obtained from the alluvium of the Clyde, along with a skull of the great urus. Had it not been for the attention of Mr. Smith, of Jordan's Hill, in preserving them until Dr. Scouler† put them on record in 1852, the discovery would have been lost to science. In 1865 Sir Philip Egerton met with a small fragment of antler in the peat bogs of Rossshire which beyond all doubt belonged to this animal.

The first instance of its occurrence in Ireland is afforded by some sketches of antlers found in 1741, in the bog of Ballyguiry, by Major Quarry, which have been in the possession of that gentleman's family ever since. In the preface to the *Zoologist* for 1836 the animal is recorded from Lough Gur, in the county of Limerick. In 1847 Mr. Oldham (now Dr. Oldham) brought before the notice of the Royal Dublin Society the "skull,

* Pennant, Quadrupeds, vol. i. p. 100. 4to.
† Edinburgh New Philosophical Magazine, 1852, vol. lii. p. 135.

horns, and lower jaw of a reindeer found by Mr. Moss at Ballybeta, near the Golden Ball, in the county of Dublin;" but the most remarkable discovery was that of a perfect skull and antler brought before the Royal Dublin Society by Dr. Carte in 1863.* The antlers are quite perfect and are still attached to the skull. The discovery was made in 1861, on the verge of the Curragh bog, near Ashbourne, in the county of Dublin. It is, beyond all doubt, the most magnificent specimen of reindeer that has ever been found in the fossil state. Dr. Carte also mentions three antlers which were found at Coonagh, on the south side of the Shannon, in county Clare. Thus in Ireland, also, the animal was rare, as compared with the Irish elk, or the *Bos longifrons*.

In the pre-historic deposits of Germany the remains of the animal have also been found. Professor Nillson quotes them from the peat bogs of Pomerania, in which they are very abundant (*An. Mag. Nat. Hist.*, Ser. 2, vol. iv., 1849, p. 264), and doubtless they will be found in many other localities as attention is more and more concentrated on the pre-historic animals. In Southern Germany, Dr. Oscar Fraas describes a very interesting refuse-heap at Schussenried, in Upper Swabia, in which the remains of reindeer were associated with those of the bear, glutton, and arctic fox, and large quantities of flint implements of the unpolished kind. In Switzerland its bones have been found in a pre-historic cavern at l'Echelle,† near Geneva, in association with worked flints, and the remains of the ox and horse. Thus scanty is the evidence of the existence of the animal in pre-historic times, but it is sufficient to prove that it still lingered in regions far to the south of its present habitat.

If we turn to history we shall see that the animal has been retreating northwards at least during the last two thousand years. In Cæsar's time it dwelt in the great Hercynian forest that overshadowed Germany. He describes it as ‡ "an ox in the shape of a stag," and as "having one antler springing from the middle of its forehead, between the ears, loftier and more directed forwards than any known to the Romans. From its palm-like top, branches spread widely. In both male and female there is the same nature—the same form and magnitude of antlers." This description has been considered by many of no value at all, and as the pure invention of Cæsar's brain. It seems to me, however, a very natural explanation of the difficulties of the passage, if we

* Geol. Mag., vol. iii., No. xii., p. 546.

† Lubbock, Pre-historic Man.

‡ De Bello Gallico lib. vi., cap. xxvi.—"Est bos cervi figura, cujus a media fronte inter aures unum cornu exsistit, excelsius, magisque directum his quæ nobis nota sunt cornibus. Ab ejus summo, sicut palmæ, rami quam late diffunduntur. Eadem est fœminæ marisque natura, eadem forma magnitudoque c rnuum."

suppose that Cæsar described the animal partly from hearsay and partly from a rude sketch in profile. In the latter case, unless the drawing were in correct perspective the animal would appear to be possessed of one horn only, and therefore he might legitimately describe it in times when a belief in all kinds of monsters was current, as possessed of one horn. To this imperfection of drawing many of the monsters in the natural history books of the middle ages may most probably be traced. It is not at all reasonable to suppose that Cæsar himself ever saw a reindeer; for he describes the Hercynian forest as stretching far beyond his ken, and then he proceeds to enumerate the animals that are found in it. The Germans, however, in his time were well acquainted with the reindeer, for in the 21st ch. of the 6th book of his *Commentaries* he writes that they use small skins of reindeer, "Parvis rhenonum tegimentis utuntur,"—a passage in which rhenones is the latinized form of the word that is now current as Rennthier (Swedish Rendjur), and which is preserved in the Romance word Renne, the root meaning being found in the German rennen, to run.* When the Teutonic invaders of Europe advanced northwards and westwards in the Hercynian forest, they met with an animal altogether strange to their eyes. They were struck with its running powers, and so they termed it the "running beast," and thus the animal acquired a name. Other writers of antiquity, such as Pliny, Solinus, and Ælian, speak of an animal which they term tarandus; their accounts, however, are purely mythical, and it may have been an elk, or, as Gesner believes, a Polish thur, as reasonably as any other animal.† In Cæsar's description the uprightness of the horns shows that he meant the true reindeer, and not the elk.

Down, indeed, to the sixteenth century, Cæsar's account is not surpassed for accuracy by any other, but for the most part formed the basis of all the descriptions of the animal written by the mediæval monks. In the thirteenth century Albertus Magnus, Bishop of Ratisbon (died 1280), describes the animal as possessed of three horns; and Olaus Magnus,‡ writing nearly three hundred years afterwards, adopts his error. He writes that, "in the north, on both sides of the Gulf of Bothnia, and in Lapland, there is an animal with three horns (*bestia tricornis*), one of the stags, but taller, stouter, and swifter. Two of the horns are larger than the rest, and situated in the same place as in the red-deer, but they are more branching and more widely extending, even

* That this is the true derivation is proved by the prominence which Olaus Magus, Albertus Magus, and Gesner give to its attribute of swiftness. Dr. Lee derives the name from the German *rein*, clean, without however giving any reason.

† Historia Naturalis, folio, 1603, vol i. p. 140.

‡ Gentium Septentrionalium Historiæ lib. xvi. cap. viii.

to the extent of fifteen tynes. There is a third horn in the middle of its forehead, with other shorter tynes surrounding it." At this time he was Archbishop of Upsal, and primate of the Goths and Swedes, and therefore ought to have known something about the animal that lived in his own jurisdiction. Besides this erroneous description, he actually figures the animal with three horns. It is clear, from the *History of Lapland*, by John Scheffer,* that he was in the habit of visiting the northern parts of his diocese, and if so he must have seen the animal with his own eyes. He seems, however, to have preferred the testimony of another bishop, who lived in a country where the animal did not exist. On the whole, a more untrustworthy writer than this archbishop perhaps never wrote a book, for he has not only believed every one of the myths current in his day, such as griffins, sea horses, whales swallowing ships, and the like, but he has even given woodcuts of them, which have not the slightest foundation in fact.

We come now to a notice of the animal which has certainly not met with the attention it deserved in England. In the *Orkneyinga Saga* the reindeer is incidentally mentioned; the passage is thus translated by a learned Icelander, Jonas Jonæus,† "Solebant comites quavis fere æstate in Katenesum transire, ibique in desertis *feras rubras* et *rangiferas* venari." The Jarls of Orkney were in the habit of crossing over to Caithness every summer, and there hunting in the wilds the red and the reindeer.‡ Torfaeus, writing at the end of the seventeenth century, has translated "rauddyri," by capreæ, or goats, and his mistake has been followed by Dr. Flemming,§ who quoted him without consulting the original. Dr. Hibbert,|| however, has given an elaborate critique on the disputed passage, and agrees with Jonæus in believing that the reindeer was hunted in Scotland by the Jarls of Orkney in the twelfth century. Professor Brandt, of St. Petersburgh, is also of the same opinion. The authors of the *Saga* must have been well acquainted with the animal in Norway, Sweden, and Iceland; and there seems to me nothing improbable in the natural inference that the animal they called reindeer was undoubtedly one. There is not the slightest record of the animal having lived in historic times in England or Wales. The Romans never conquered Caithness, and the high-

* Lapponia. 4to., 1673.

† He published in 1780 an abstract and Latin translation of the "Saga." The passage in the original is as follows: "That var sithr Jarla nær hvert sumar at fara yfer á Katanes oc thar upp á merkr at veida *randdýri* edr hréina." The two Jarls in question, Ronald and Harold, hunted in Caithness, according to Jonæus, in 1159.

‡ Rerum Orcad. Hist. lib. i. cap. 36.

§ British Animals. 1828. 8vo.

|| Brewster's Edinburgh Journ. Sc., New Series, vol. v. p. 50.

lands of Scotland were so utterly unknown to the English of the middle ages, that even so late as the time of William III. they were looked upon very much as we now look upon the extreme north of Lapland. In this way the absence of any historical notice of the animal may be accounted for. The inclement hills of Caithness lie in the same parallel of latitude as the south of Norway and Sweden, in which the animal was living at the time. Reindeer moss is very abundant for the animal to eat, and the only condition of life which is wanting to make that country still habitable by it is a greater severity of cold. I feel disposed, therefore, to admit the fact that the reindeer lived in Caithness at the time that Henry II. occupied the throne of England and Alexander Neckam was writing his *Natural History*. There is also another point which is well worthy of notice. The animal is mentioned in the *Saga* along with "the red-deer." At the present day they occupy different zoological provinces, so that the fact of their association in Caithness would show that in the twelfth century the red-deer had already appropriated the pastures of the reindeer, which could not retreat further north on account of the sea. Hence the association of these animals in the same area proves that the latter was verging towards extinction. The exact date of the disappearance of the reindeer from North Germany and the district to the south of the Baltic is not known; according to Bartholinus, it had deserted Denmark before the year 1671. From Linnæus' time down to the present day, even in Sweden and Norway, it has been retreating further and further north.

We have thus traced the range of the animal in Post-glacial and Pre-historic times, down to the present day. During the Post-glacial period it dwelt, as we have seen, throughout Europe north of a line passing through the Alps and Pyrenees, in vast herds, associated with the cave hyæna and tichorhine rhinoceros. During the Reindeer epoch it lived also in vast herds in France and Belgium. In Pre-historic times it is found sparingly in Britain, Switzerland, and abundantly in the north of Germany. When Cæsar wrote his *Commentaries* the animal had left Gaul and taken shelter in the great Hercynian forest. Before his landing in Britain it had most likely departed from the whole of the island which subsequently formed the province of Britannia. If this did not take place before the Stone or Bronze age in Britain the animal must have been very rare, for while the other objects of the chase are represented by vast quantities of bones in the tumuli and villages, not the least trace of it has yet been found. It most probably, therefore, had taken refuge in the inclement hills of Caithness before the commencement of history in Britain. There it lingered on, struggling for life with the red-deer until, towards the end of the twelfth or

the beginning of the thirteenth century it became extinct. In Germany, also, it seems to have retreated, and taken refuge in Pomerania and Denmark in the middle ages. In the middle of the seventeenth century it could no longer live in Denmark,* and at the present day it has found uncertain resting places in the north of European Russia and the mountains of Scandinavia, where it is daily becoming rarer, and daily seeking refuge from the hunter by a retreat northwards towards the shores of the great northern sea, and westwards towards the great Siberian tundras.

Nor, indeed, can the reindeer be induced to live in the countries which were formerly their own. The Duke of Athol † attempted to reintroduce them into Scotland without success, and even an attempt made to naturalise them in Denmark, in the first half of the eighteenth century, failed.‡ In Cassel also, Dr. Zimmermann § writes, that they were kept in a park; but in no case on record in any of these countries have they propagated their kind. Without exception, all have died barren. The reason, therefore, of their northern retreat cannot be the dread of the hunter, as has been suggested, for all possible pains were taken to preserve them. The red-deer, moreover, would not have thriven and multiplied in the countries which they deserted, for the flesh of the former is, if anything, better than the flesh of the latter, and the former is quite as easily captured as the latter. We must seek, therefore, a far deeper cause. No one would dispute the intense cold of the Glacial, or the severe climate of Central and Western Europe in Post-glacial times, during which the reindeer was so abundant; but many would be inclined to deny the gradual amelioration of our climate in the Pre-historic and Historic eras. That, however, the climate has changed since Cæsar's day is proved by the concurrent testimony of Buffon, Zimmermann, and Gibbon.|| The German invaders of the Roman empire transported their numerous armies, their cavalry and heavy waggons, over the Rhine and Danube, over a vast and solid bridge of ice. On the banks of the Danube the wine, when brought to table, was frequently frozen. Thus we have clear historical proof that the climate of Germany, in the days of Ovid, Virgil, Herodian, and Diodorus Siculus, was much more severe than it is now. We therefore not only know that the reindeer existed in Germany in those times, but that the physical conditions also were, to a certain extent, of an arctic character. Coincident with the climatal change that has taken place since

* Acta Hasnens, 1671.

† British Animals, Flemming. 1828.

‡ Œuvres de Reynard, tom. i. Paris 1750.

§ Specimen Zool. Geograph. 4to., 1777, p. 283.

|| Decline and Fall of Roman Empire, cap. ix.

that time is the migration of the reindeer to the north and east.

The date of the disappearance of the reindeer from any given country affords us an index to the climate at the time. Long before Cæsar landed on our shores the arctic conditions favourable for their life had vanished away. When Cæsar wrote his *Commentaries* they were still to be found in the north of the great Hercynian forest. They had already departed from the low country of Gaul. During the middle ages the climate gradually changed in Germany, until, in the middle of the seventeenth century, the reindeer had even forsaken Denmark. In Caithness, however, the most northern and inclement portion of our island, hemmed in on the one hand by the sea, and on the other by the continually encroaching herds of red-deer, they lingered long after they had disappeared from Gaul, until at last they became extinct, probably about the beginning of the thirteenth century. The cause of the gradual amelioration of climate in modern times is generally attributed to the draining of morasses and the cutting down of the forests. On this point, however, the former range of the reindeer gives most conclusive testimony. Before the hand of man had made any impression on the vast forests that overshadowed Germany and Britain, the animal had commenced its northward retreat, and therefore the climatal change must have been going on at that time. We cannot therefore ascribe the change to the industry of man, but to some great cause operating through an inconceivably long time, from the Glacial epoch of intense arctic severity down to the temperate climate of the present day. It is indeed but a return to the order of things in Pre-glacial times. The Glacial epoch came in abnormally, so to speak, disturbing the temperature of the northern hemisphere, and driving the animals that dwelt in that area before it. It lasted an inconceivably long time, so long, indeed, that very many of the European pre-glacial animals became extinct, and it left its impress in the presence of the musk, sheep, reindeer, marmot and lemming, among the post-glacial mammals. As the climate became warmer they disappeared, and had not the hand of man intervened, there is every probability that the wild animals of a far more southern character would now be living in Europe, such as the common hyæna and the lion. The cause of the great refrigeration of our climate is still unknown; but the most philosophical explanation is that brought before the Royal Society, in 1866, by Mr. John Evans, F.R.S., viz. the alteration of the earth's axis of rotation, consequent on the elevation or depression of some part of its crust, which must necessarily destroy the equilibrium.

THE SCIENCE OF A SNOW-FLAKE.

By ROBERT HUNT, F.R.S.

> Thick clouds ascend; in whose capacious womb
> A vapoury deluge lies, to snow congealed.
> Heavy they roll their fleecy world along,
> And the sky saddens with the gather'd storm.

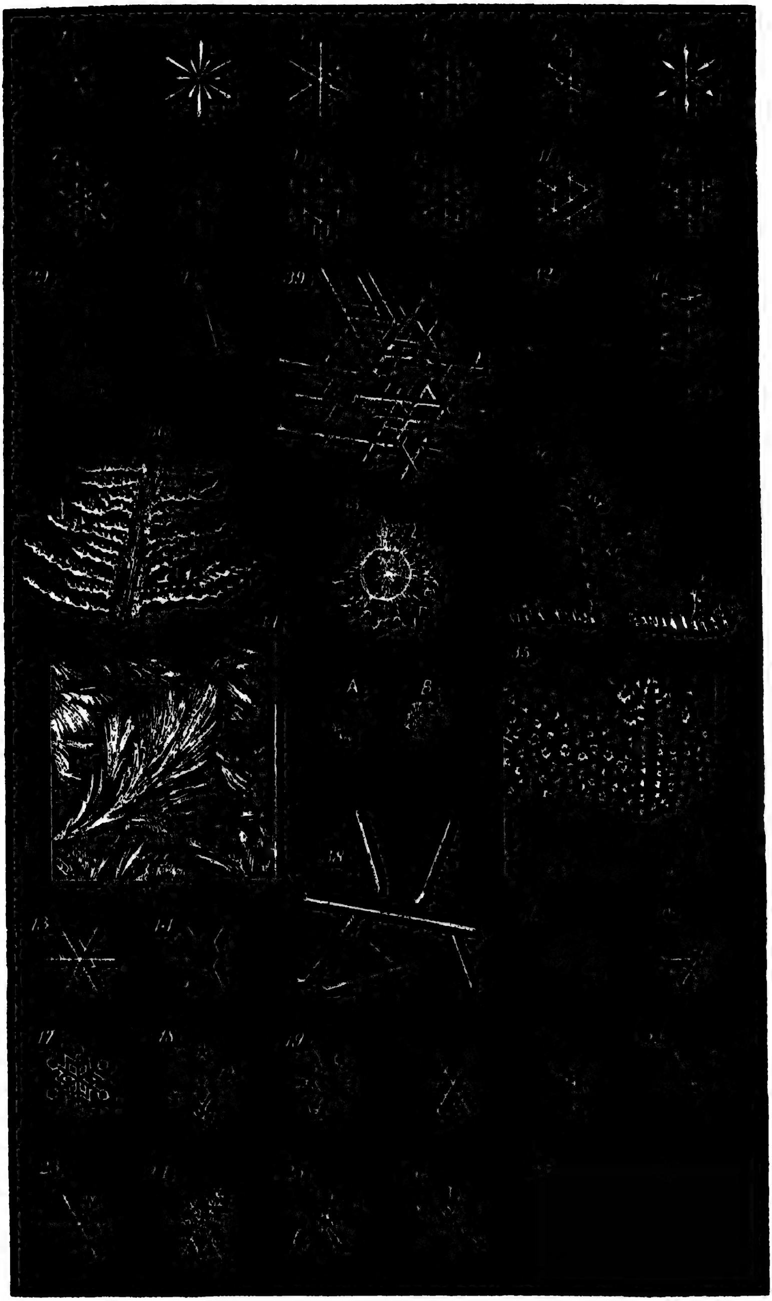
THE poet of "The Seasons" was a close observer of natural phenomena, and no one described more lucidly than Thomson did, the varying aspects of the year. But whenever the poet attempted the part of a natural philosopher he invariably failed. The lines quoted above are a fair example of that imperfect knowledge of science which Thomson possessed; indeed they may be said to exemplify the kind of information which was common amongst the educated classes at the commencement of the eighteenth century.

In the capacious womb of the clouds the vapoury deluge *does not lie* to snow congealed, even in the utmost severity of a winter snow-storm. The retention of water-vapour in the air, and the condensation of it into clouds, or fog, or its precipitation as dew, rain, hail, snow, or hoar-frost, are processes very different from that which—even with the utmost practical license—can be understood by a vapoury deluge to snow congealed. The lines which follow are however so true to nature that they must be quoted as an example of beautiful descriptive poetry, well adapted to be the motto to the present essay:—

> Through the hush'd air the whitening shower descends,
> At first thin wavering; till at last the flakes
> Fall broad and white and fast, dimming the day
> With a continual flow. The cherish'd fields
> Put on their winter robe of purest white.

It appears necessary, especially for the benefit of the younger class of our readers, who may be induced to give a little attention to the wonders of a snow-flake this winter, that the conditions, as far as they are known, under which water is disseminated through, and held suspended in the air, should be examined.

Around the Earth, like "a great green serpent twining," we



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Snow Hail and Frost

have the wilderness of waters called the sea. The ocean covers about three-fourths of the surface of the globe, or it occupies nearly 110,849,000 square British miles, and, equally over both sea and land, the vast atmospheric ocean flows. If we place perfectly dry air, contained in a bell glass, over water, we shall find that water-vapour will rapidly ascend and diffuse itself through it—the quantity being regulated by the temperature of the apartment in which the experiment is made. At all temperatures, down to that at which water freezes, the air takes up water-vapour; and this process is facilitated by the constant movements of the sea and the currents of the atmosphere. Therefore, we learn that the envelope surrounding this earth is an atmosphere of permanently elastic fluid, mixed with aqueous vapour in constantly varying proportions, the variations being regulated by the temperature. Meteorologists have found it necessary to a clear understanding of the phenomena which are brought under their consideration, to study the conditions which would prevail, if the atmospheric elastic fluid—Air—existed in a perfectly dry state. The air does not derive much heat from the sun-rays passing through it, but it is warmed by its contact with the earth; and this heat is conveyed from particle to particle—this process being known as convection, the act of carrying or conveying. The solar rays fell with different degrees of intensity on the equatorial and polar regions; we have in the former the maximum and in the latter the minimum of heat absorbed from the sun. As a particle of air becomes heated it expands, and becoming specifically lighter than the particles above it, it ascends, giving place to the colder and heavier ones. Thus the heating power of the sun becomes the mainspring of all the motions of the atmosphere, and, indeed, of those of the ocean. From the lands under the equator an upward current of air is thus generated, and the space occupied by the air thus removed, is supplied by currents of colder air flowing in from the poles. The ærial currents are complicated by the motion of the Earth and by other conditions which cannot be considered here. Sufficient for the present purpose that we understand that they are, in the main, the result of processes of heating and cooling which are regulated by an unvarying law.

The habitudes of an atmosphere of pure aqueous vapour have also been, necessarily, the subject of close and attentive study; but we have to consider only the habitudes of a gaseous atmosphere mixed with vapour, that vapour being derived from the oceanic waters in the first instance, and from the evaporation, which is constantly going on over the land, of the waters which have fallen from the air. Dr. Dalton discovered that the evaporation of water has the same limits in air as in a vacuum. Hence it is only necessary to know the quantity of vapour which

rises into a vacuum at any particular temperature—the same quantity rises in air. Thus the vapour which rises into a vacuum at 80° has a tension equal to one-thirtieth of the usual tension of the air. Or, if water at 80° be allowed to diffuse itself into dry air it increases its bulk by 1·30th if the air is free to expand, or it increases its tension by 1·30th if the air be confined. The spontaneous evaporation of water is therefore influenced by three circumstances. 1st. By the previous dryness of the air—for the air will only, under any circumstances, hold a given, and now well-determined, quantity of moisture. 2nd. By warmth—the higher the temperature the more considerable is the quantity of water-vapour which rises into any accessible space; therefore humid hot air contains a much greater portion of moisture than humid cold air. 3rd. The evaporation of water is greatly accelerated by the constant removal of the air from its surface. Currents of air—Winds—are favourable to evaporation, because each portion of air takes its quantity of water-vapour; it is removed, and another portion sweeps on to take its dose of humidity. The atmosphere may be regarded as a series of concentred zones of air, each one having, according to its distance from the Earth, its own density and its own temperature; therefore each zone will possess its peculiar capacity for water-vapour. Air, for example, may become saturated with water-vapour within a short distance of the surface of the land and sea, and remain perfectly transparent—free from cloud. This belt of air being warmer than the belt above it, rises; and as it parts with its warmth, which it will do by expanding as the pressure is diminished, and also by its contact with colder air, some of the vapour is condensed and clouds are formed.

It has been determined that over the land the cloud region varies from about three to five miles, but this is greatly influenced by the configuration of the land itself. Over the sea this region of vapour is more constant. Balloon ascents have shown that over England the cloud region has a thickness varying from 1,500 to 3,000 feet, and that the temperature at the top is not lower than it is at the bottom, notwithstanding its thickness.

The influences which effect—and are constantly disturbing the solution of water in air—its retention as invisible vapour, or its precipitation or condensation as visible vapour or cloud, are numerous; but if it be distinctly understood that these influences are dependent upon solar and terrestrial radiation it will suffice for the present purpose.

When a condensation of vapour takes place, if the temperature of the air be above 32°, the matter condensed is liquid, or in form of *rain*. If the drops of rain pass through a stratum of air, having a temperature below the freezing point of water, they are frozen into ice, and form *hail*. If a band of humid air having a

temperature sufficiently high to maintain the vapour in its transparency, is brought into contact with a cold belt of air—that is, below the freezing point of water—the vapour is frozen as it is condensed, and each particle forms a spicula of ice, and these spiculæ combining form *snow*. When, by a reduction of temperature, a condensation of vapour takes place, a multitude of infinitely fine drops form a cloud, a mist, or a fog. These minute particles of water descend very slowly through the air, and if they enter into a stratum of air—which, being warmer, has a capacity for imbibing vapour—they may be, and often are, rapidly reabsorbed, and the cloud which they produced, may disappear. It is exceedingly interesting to watch the formation of the clouds in summer. A cloud, like a floating feather, gradually increases in size, and ever varying in form floats slowly on, relieved against the deep blue of space; it falls and it rises, and perchance even while we are watching its dream-like changes it is gone—the vapoury wreath has been absorbed by a warmer belt of air. On the other hand, if the condensation goes forward, and the lower region of air has its quantity of vapour, the small particles meeting one another will coalesce and form drops to fall as rain on the Earth's surface. The rain particles are ever fluid; those which form snow are frozen, ere by coalescing they arrange themselves—in obedience to some mysterious law of crystallisation—into the beautiful *snow-flake*. If the capability of the atmosphere for absorbing moistures remained the same at all temperatures, or were its capability increased in an exact ratio with the increase of heat, no change produced by the admixture of two streams of air, of different temperatures, could occasion the formation of rain or snow. But as was first shown by Hutton, and confirmed by Leslie, "while the temperature advances uniformly in arithmetical progression, the dissolving power which this communicates to the air mounts with the accelerating rapidity of a geometrical series, and this in such a ratio that the air has its dryness doubled at each rise of temperature answering to 27° of Fahrenheit. Hence, whatever may be the actual condition of a mass of air, there must always exist some temperature at which it would become perfectly damp." Whenever two streams of air, saturated with moisture, of different temperatures are mixed together, or float in contact with each other, in the form of different currents of wind, there must be a quantity of moisture precipitated, cloud formed, and if the temperature of one of the ærial currents falls below 32°, *snow* must be the result. We know that electricity appears to produce the condensation of cloud-vapour into ice—Hail—and the devastating hail-storms of southern Europe are evidently of electrical origin. But it must be remembered, that the electricity acts by producing a rapid reduction of ærial temperature, probably by the expansion of the

gaseous fluid, and that therefore the hail-storm is directly produced by the abstraction of heat alone.

The snow-flake must now engage our attention. In the colder regions of the earth, when the external air is allowed to enter into a heated apartment, which is consequently charged with water-vapour, a very fine snow is at once formed. As the warm air of a first-class railway carriage, full of passengers, moves towards the ice-covered windows, it is not unusual to witness this phenomenon—the production of snow in fine powder. This may be regarded as the elementary state of snow. These particles, when viewed under a microscope, although they are transparent particles of ice, have not the appearance of any regularly crystallised form; but they possess the power of arranging themselves into compound crystalline forms of exquisite beauty and of almost infinite variety. There is little doubt but careful examination under favourable circumstances would lead to the discovery of a primary form, constant to the snow crystal, in this snow powder.

M. Quételet has endeavoured to show that there is a relation between the density of the snow particles and the forms which by coalescing they assume. The density of well-formed small stars being about $\frac{1}{28}$—water, from a constant mass of snow being regarded as unity—the temperature varying from 29° 7′ to 18° 5′. Unformed flakes at a temperature of 33° had a density of about $\frac{1}{5.6}$, and fine snow, the temperature varying from 32° to 30° 2′, was found with a density of $\frac{1}{7}$ and $\frac{1}{7.5}$.

Dr. Nettis, of Middleburgh, was the first to describe snow crystals. In the severe winter of 1740 the cold was most intense. Dr. Nettis collected the snow on plain surfaces of glass. The crystals were hard and pellucid; by means of a pencil they were removed to the microscope and examined. Eighty different figures were obtained, the size of which varied from $\frac{1}{20}$ to $\frac{1}{3}$ of an inch. To the late Dr. Scoresby we are, however, especially indebted for an extensive examination of those exquisite productions of nature (*Account of the Arctic Regions*, &c., 1820). He tells us that nine days out of ten during the months of April, May, and June, snow falls in the Arctic regions. With southerly winds, near the borders of the frozen sea, or in situations where humid air blowing from the sea assimilates with a gelid breeze from the ice, the heaviest falls of snow occur. When the temperature of the air is within a degree or two of the freezing point, the snow is usually in large irregular flakes, such as fall in this country. Sometimes it exhibits small granular or large rough white concretions; at others it consists of white spiculæ, or flakes composed of coarse spiculæ, or rude stellated crystals, formed of visible grains. "But in severe frosts, *though the sky appears perfectly clear*,

lamellar flakes of snow, of the most regular and beautiful forms, are always seen floating in the air, and sparkling in the sunbeams; and the snow which falls in general is of the most elegant texture and appearance."

The principal configurations of the snow-crystals are thus arranged by Dr. Scoresby:—

1. Lamellar.
2. A lamellar or spherical nucleus, with spinous ramifications in different places.
3. Fine spiculæ, or six-sided prisms.
4. Hexagonal pyramids.
5. Spiculæ having one or both extremities affixed to the centre of a lamellar crystal.

The first kind appears to admit of almost infinite variety, the more remarkable being the *stelliform*, having six points radiating from a common centre. Fig. 14 is typical of this species. See also figs. 1, 2, 3, 4, 5, 6, and 20, 21, 22, &c. It occurs in the greatest abundance when the temperature approaches the freezing point. *The regular hexagon* (figs. 26, 27, 28) occurs in moderate, as well as in the lowest, temperatures; the structure of those crystals is, however, more delicate, and their size is diminished as the temperature is lowered. The *aggregation of hexagons* is a beautiful species (figs. 17, 18, 19), admitting of endless variety. Again, the *combination of hexagons with radii or spines and projecting angles* are no less interesting, and they are far more numerous than the former (figs. 9, 10, 11, 12, are typical. Several others are represented in the Plate). Of the second general division there appears to be but two or three species. The fundamental figure is of the kind already described; and from the lateral and terminal planes there arise small spines like the collateral ramifications of figs. 23 and 24. The third class contains examples of very delicate crystalline forms, sometimes like figs. A and B. The finest specimens, however, resemble white hair cut into lengths, but so small and clear as not easily to admit of an exact determination of their figure. Occasionally they are found with a fibrous or a prismatic structure. The fourth class, or pyramids, generally hexagonal, are very rare (figs. 31, 32). They were observed by Dr. Scoresby on but one occasion; and the crystals of the last species named are nearly as rare, having been seen only on two occasions (figs. 29, 30). The examples to which references have been given, and the other figures, such as 7, 8—15, 16, 25, on the Plate, will fully illustrate the general character of those curious and beautiful forms which are assumed by water under the conditions necessary for the formation of snow.

Let us examine, by the lights which we have, the pheno-

menon of the snow-flake; and to do this we must observe the conditions of freezing water in all its aspects. A little experiment will assist us. If a saturated hot solution of sal-ammoniac is allowed to cool in a tall glass, it will be seen that, as the surface, which is the first part to cool—being exposed to the currents of air passing over it—solidifies, feathery crystals, like those of snow, fall through the fluid. Here, with a little care, we may watch the accretion of particle to particle, to form eventually, ere it reaches the bottom, the resulting crystal, which is not unlike a snow-flake, and thus learn how nature builds up her crystalline forms.

If we freeze water in a transparent vessel, we shall at first see needle-like points of ice shooting out from the sides: that is, from hair-like crystals just visible, we may observe them enlarging into needles, or small blades of ice, as shown in fig. 38. By-and-by, the process of refrigeration going forward, it will be perceived that these needles or blades combine, as shown in fig. 39. Here, as in the snow crystals, we may detect the same law of combination; every two of the spiculæ are separated by an angle of 60°. If we watch the freezing of moisture on the window-pane we shall see the same process; resulting eventually in the formation of fern-like figures, mimicking the graces of the most exquisite productions of the vegetable world. Sometimes a sheet of frost is formed, by rapid congelation, over one portion of a window-pane, and the arborescent forms are generated above it, by a slower process of solidification (fig. 35); and at other times, the full sheet is covered with a fairy vegetation, the temperature determining the one or the other state (fig. 34). The same condition is observed under other circumstances, especially on the surface of a pavement (figs. 36, 37). Hessell and Luke Howard have both observed the formation of hexagonal crystals on the window-pane; and Howard remarks that the air next the earth is "sometimes loaded with particles of *freezing* water, such as in the higher regions would produce snow. These attach themselves to all objects, crystallising in the most regular and beautiful manner. Shrubs, covered with spreading tufts of crystals, look as if they were in blossom, while others, more firmly encrusted, appear like gigantic specimens of white coral. The leaves of evergreens are found with a transparent varnish of ice, and a delicate white fringe around. On such an occasion the whole face of nature seems dressed out in frost-work." Thus we have evidence that the same law, which regulates the formation of snow in the higher regions of the atmosphere, is in operation in the formation of frost upon the surface of the Earth. We also now know, from the experiments of Dr. Tyndall, that "every atom of the solid ice which sheets the frozen lakes of the North has been fixed according to this law"—the law which determines the structure of the snow-

crystal which we have been considering. In the *Popular Science Review*, vol. v. pp. 52, 53, the revelation of the structure of ice, by Professor Tyndall, has been very satisfactorily told.* The beauty latent in a block of ice has been prettily described by its discoverer as "stars, each one possessing six rays, each one resembling a flower of six petals; then the petals become serrated and spread themselves out like fern-leaves."

Such is the science of the snow-flakes, which make winter drear, and which do not usually give evidence of those forms of beauty that belong to it; simply, because those geometric figures have during the driving onward of the cloud which

> Lifts the snow on the mountains below,

been hurried into irregular flaky masses.

Professor Leslie supposed that a flake of snow, taken as nine times more expanded than water, descends thrice as slow; hence the tendency of snow to be driven onward, and to accumulate into those *drifts* which so entirely block up roads, and gather into great and dangerous masses under the shelter of any obstructing object, often burying both man and beast. Sometimes, when a strong wind blows over the surface of snow, portions of it are raised by its power, and passing onward gathers other portions, which by attrition assume globular forms. In a severe snow-storm in 1814 Mr. Howard saw several thousands of these natural snow-balls formed, and in my own garden I observed their formation on Sunday, December 8. Mr. Sherriff records an instance of balls being found by him, in 1830, in East Lothian, varying from a foot to eighteen inches in diameter, which left hollow tracks in the snow. These are striking examples of the peculiar adhesive character of snow, which results from its needle-like crystalline structure. Every boy knows how hard he can make his snow-ball by squeezing it; and if the pressure is applied with sufficient force, a ball of ice will result. In this case, however, something more than the mere adhesion of the snow particles takes place. Some of the snow is, by the development of a small increment of heat, liquified; this immediately freezes, and thus unites the mass. This process is known as *regelation*. When a considerable thickness of snow falls upon the surface of the earth, the lower portion consolidates by the combined influences described; and if this takes place upon a mountain, the consolidated portion is pressed downwards and onwards, forming

> The glacier's cold and restless mass,

which

> Moves onward day by day.

* *Glaciers and Ice*, by W. F. Barrett. Read also *Heat Considered as a Mode of Motion*, by John Tyndall, F.R.S., pp. 108–111.

A very curious condition of the conversion of falling snow into ice sometimes occurs in those severe hail-storms, in which really oval-shaped masses of ice fall to the earth, doing great damage. If those are examined, they will be found to have a nucleus of snow, and over this a layer, sometimes two or three layers, of ice (see fig. 33). These have evidently been formed rapidly, and there is no doubt but that they are the result of a refrigeration of layers of air by electrical disturbances. Snow has been first produced; then, the falling flakes have passed through air saturated with cold moisture, and lastly through air below the freezing temperature. It has been already shown, that the snow which clothes the mountain-tops with a permanent robe of whiteness, has been lifted to those heights from the surface of the ocean by the action of the sun's rays. Water has been vapourised by the solar heat, and borne to the upper regions of the air, where, meeting with a temperature below the freezing point of water, it is condensed as snow. The limits of perpetual snow are fixed by the temperature of those elevated regions, and of course the snow-line varies greatly as we pass from the equator towards the pole.

Humboldt fixed the altitude of perpetual snows under the equator at 15,748 feet. On the northern sides of the Himalaya mountains it is about 17,000 feet, and on Chimborazo 15,802 feet. On the Alps and the Pyrenees it is about 8,850 feet; at the North Cape, in latitude 71°, it is estimated at little more than 2,000 feet. But, beside the constant data of latitude and elevation, the position of the snow-line depends on variable causes; such as the form of summits, the comparative altitude, and other physical features, of the surrounding country; the particular exposure of the mountains, and even the character of the neighbouring vegetation; therefore no general rule can be given for fixing the limits of perpetual snow in any given latitude. Our own temperate island, upon which we have no mountains high enough to be constantly snow-clad, is an example in illustration of this. The evidence exists, which tells us with unmistakable force, that there was a time, however, when the mountains of Scotland and Wales were within the limits of the line of perpetual snow—when, indeed, glaciers moved down the vale of Llanberris, and, according to some geologists, scooped out the lakes of North Wales and Scotland. We are not in a position to say at what period this state of things existed, but we do know under what conditions it might be renewed.

The present temperature of the British Isles is mainly due to the action of the Gulf stream. This great river of water, flowing through the sea, comes warmed by a tropical sun from the shores of Central America, and washes our land. It is found in the winter, that, off the Scilly Islands, the western coast of

Ireland, and of Cornwall, the sea is some ten degrees warmer than the land. Hence it is that snow is rare in those parts, and that it seldom lies upon the ground many hours. The warm air coming with the Gulf stream spreads over the United Kingdom, and mitigates that severity of winter which belongs to our latitude.

Let the Gulf stream be interrupted, and the conditions of the Glacial epoch would be renewed. If Plato's dream of a New Atlantis were realised, and a tract of land should arise out of the ocean between us and America, cutting off the warm waters of the Gulf; Snowdon and Ben Lomond would have an everlasting diadem of snow, and the glazier would again move, in its cold but solemn grandeur, down the valleys, where now the rose and the lily find a genial home.

THE FOOD OF PLANTS.

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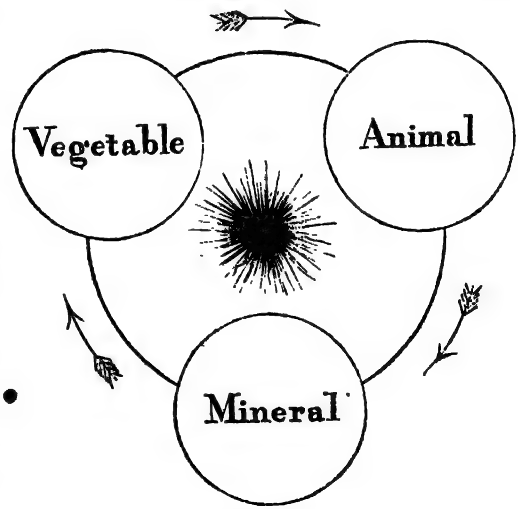
MEAT and drink are not one whit less important to the plant than to the animal. The tree that seems to use the ground merely that it may therein fix its anchoring roots; the rain, to brighten its fair garment of foliage; and the air, that it may therein spread the balanced beauty of its boughs, draws from all these—the earth, the water, and the air—the very substance and breath of life. Indeed, all four of the ancient so-called elements are concerned in the nourishing of the plant. For without the threefold energy of the solar fire, earth, water, and air would contribute their stores in vain. It is in the power which plants possess of securing, in latent yet available shape, the forces of the sun that they afford so striking a contrast to the spendthrift character of animal functions. Plants gather together from inorganic materials, and from the waste products of organisms, fresh supplies of complex materials, prepared and fitted for the nourishment of animals. The food of plants is oxidized food, food which animals cannot assimilate; and plants have the power of utilizing the sun's heat in pulling apart the constituents of these oxidized compounds. Once apart, these constituent elements are arranged in new compounds, compounds containing less oxygen, but ready, by combining with oxygen when used as food or fuel, to transform their pent up and concealed energy into heat and its correlative forces.

But although in their food and in their mode of feeding plants differ from animals, yet there are analogies, not only apparent but real, between them. Animals breathe—so do plants; animals require certain elements arranged in certain combinations—so do plants; animals need their food in a particular form or mechanical condition—so do plants; animals may be stimulated by special kinds of food—so may plants. Yet with all these similarities between plants and animals, when we come to investigate more closely the laws of vegetable nutrition, we find at once such differences as those we have now mentioned, differences not only in special details but also in general functions.

There is very great difficulty in thoroughly ascertaining the mode in which plants acquire their food, and the exact processes by which the several chief vegetable substances, cellulose, starch,

albumen, oil, &c., are built up from inorganic compounds. But there are several ways of learning with certainty not only what elements are essential to a plant, but also in what form of combination the several elements must be supplied. One may learn much concerning these points by studying the constituents of fertile and sterile soils, or by the chemical analysis of the plant itself; or by an examination of the final products of decay into which animals are resolved after death; or by experiments tried on plants; or even by careful scrutiny of the constituent elements of animals and animal secretions. By such means, then, but especially by the chemical pulling to pieces or analysing of plants, has much information been obtained as to the elements invariably found in all plants, and concerning those occasionally occurring in particular orders, genera, or species. We will endeavour in the present paper to give an outline of the chief facts concerning the food of plants, filling in here and there, for purposes of illustration, some of the minuter details which careful chemical investigations have revealed.

Plants connect the mineral with the animal kingdom, and without plants animals could not exist. Looking at this connection in its broadest features, omitting details and exceptional or reverse actions, we may express in a simple diagrammatic sketch the relations of the three kingdoms of nature. Let the cycle of changes be represented by a large circle, and let the several spheres of chemical substances and chemical changes, mineral, vegetable, and animal, be represented by smaller circles, epochs or stages, as it were, in the system, with the sun as its centre, then we have a plan like this.



Here we see how mineral substances nourish the plant, and are transformed into vegetable tissues and products; how the plant feeds the animal, being transformed into its flesh and bones; and how, as the last step in this perpetual circulation of matter, the animal after death relapses once more into purely inorganic

compounds. Let us now briefly examine part of this series of changes, looking at the mineral food of plants and the elements which this food furnishes. We purpose to answer these two questions—"What elements occur in plants?" and "In what compounds must these elements be supplied?"

It is usual to speak of the several constituents of which plants consist as organic and inorganic; but the distinction is almost wholly false. All the constituents, or, we will rather say, all the elements found constantly in any species of plant are equally necessary to its organism; to be such an organised structure as it is it must have, or have had, all of them, though in different proportions. The error has arisen partly from the fact that *organic* compounds (such as starch, cellulose, fibrin, &c.) found in plants, when quite pure leave no ash or incombustible mineral residue when burned; they contain only the four so-called organic elements, carbon, hydrogen, oxygen, and nitrogen, and occasionally sulphur as well. But the so-called inorganic elements, the calcium, the potassium, the iron, &c., are as essential to the organism of the plant as the carbon and hydrogen. The living plant cannot exist without them—cannot perform its functions in their absence, although the dead organic products derived from the plants may be obtained free from all these incombustible or ash constituents. By the earlier plant analysts the presence of these cinereal matters, often so minute in quantity, was considered accidental; it was thought that they were absorbed by chance along with the true organic nutriment of the plant. This organic nutriment theory has itself also been at last abandoned, and very few chemists retain any remnant of the old view that plants live upon "humus," itself one of the first products of the decay of vegetable matter.

A good division of the elements of a plant, if we must have a division, is into (1) the volatile, or combustible; (2) the non-volatile, or incombustible. Of course, some of the constituent elements, like oxygen and sulphur, will partly escape, among the volatile products when a plant is burnt, and partly remain in the ash; still there is some convenience in this classification, and it is often adopted. Below is a list of all the elements found in plants, and their symbols, arranged into a volatile and a non-volatile group:—

Volatile Elements.	Non-Volatile Elements.	
Carbon, C.	Silicon, Si.	Fluorine, F.
Hydrogen, H.	Phosphorus, P.	*Bromine, Br.
Nitrogen, N.	Chlorine, Cl.	*Iodine, I.
Oxygen, O.	Potassium, K.	*Aluminium, Al.
Sulphur, S.	Calcium, Ca.	*Zinc, Zn.
	Sodium, Na.	*Cæsium, Cs.
	Iron, Fe.	*Rubidium, Rb.
	Magnesium, Mg.	*Copper, Cu.
	Manganese, Mn.	

Of the 65 known elements, 13 are universally allowed to be absolutely necessary constituents of all plants. To these may be added two others, fluorine and manganese, which are probably present in minute proportions in all plants; although it is only of late years that we have acquired distinct evidence on this point. The reasons for suspecting fluorine and manganese to exist in plants may be here cited as excellent illustrations of the indirect way in which obscure constituents of plants have been discovered. Fluorine, it is well known, exists in the bones and teeth of the higher animals in notable proportion, in the form of calcic fluoride. Now, if the plants on which such animals chiefly feed did not contain fluorine, whence could they draw constant supplies of this necessary element? Not by chance traces of fluorides in the particles of earth taken into their system along with the herbage; this plan would be not only contrary to analogy, but too capricious to be relied on. Now, very careful analyses of many plants have shown them to contain a distinct proportion of fluorine. The phosphoric acid which forms so large a part of bone is not more certainly contained in vegetables and supplied by them to animals than is fluorine. Moreover, it is instructive to note that both phosphoric acid and fluorine are present together even in such minerals as apatite, osteolite, &c., just as they are also together present in bones. With regard to manganese, it constantly accompanies iron in the mineral kingdom; and in plants likewise which contain much iron a considerable proportion of manganese is often found. One way in which the existence of manganese in a plant may be anticipated is of considerable interest. The ash of silk contains manganese. Even if one fails to detect this element in the ash of the egg, one has no difficulty in finding it in the ash of a single cocoon. Whence has this metal been derived then? Of necessity from the mulberry leaves, or other vegetable, on which the silkworm has been fed. But if manganese and fluorine be accepted as general and essential elements of all plants, there are other constituents the presence of which has not yet been shown to be general. We have placed a star (*) opposite to the names of these elements. They have been found in particular orders, genera, or species of plants, but the history of their occurrence and distribution is still in some cases obscure. Aluminum has been found in certain species of Lycopodium and Selaginella; the history of the Zinc violet, Viola calaminaria, of the neighbourhood of Aix-la-Chapelle, has been the theme of much interesting discussion. Bromine and iodine are found in marine algæ, and, indeed, the latter of these elements might still have remained unrecognised, had not it been accumulated in sea-weed from the minute proportion of it existing in the ocean. The rare and recently-discovered alkaline metals, cæsium and rubidium, have been detected

in tobacco and beetroot, while copper has been frequently observed in vegetable products used for food, and, as it exists in the feathers of certain birds, the plantain-eaters of west and south Africa, it is most likely present in their vegetable food.

Arguing, then, from such data as the above, we may classify the constituent elements of plants into those which are invariably and those which are exceptionally present. In our previous list are included 22 elements: of these therefore the first 15 are general and invariable; the latter seven particular and exceptional. Our knowledge on this point is, however, certainly open to modification, and in speaking of *all* plants we are not in a position to include under this term the lower and simple forms of vegetable life, of the ash constituents of which but little has yet been ascertained.

Of the 15 invariable elements of plants to which our further remarks must be confined, six are metals and nine non-metals. The six metals are potassium, calcium, sodium, iron, magnesium, and manganese; the eight non-metals are carbon, nitrogen, hydrogen, oxygen, phosphorus, sulphur, silicon, chlorine, and fluorine. None of these elements, save oxygen and nitrogen, exist as such in the plant; they are not contained in it free, but combined. In what forms of combination they really exist we cannot here stop to inquire; we confine ourselves to the question—In what forms are they supplied to and used by the plant?

Attempts to feed a plant upon its fourteen necessary elementary constituents in a pure and uncombined state would not succeed: it is not nourished by them, but perishes; they are for the most part positively poisonous to it. Carbon, calcium, and the rest of these elements are not food to the plant, save when they exist in certain kinds of combinations. Pure, uncombined, they are no more food to the plant than they are to the animal. Dissected or analysed food, though it be elements of food, is not food; it is as useless to the plant as a stone in lieu of bread to the animal. The right elements indeed must be there, but they must be rightly combined. Not as free elements, but only after they have entered into combination with certain other elements, and that in certain proportions, are they taken up and assimilated by the plant. For these compounds, the ingredients of plant food, we have to look in three places—the air, the water, and the earth: the air which surrounds the stem and foliage of the plant, the soil in which its roots penetrate, and the water which, in the form of rain, dew, and mist, comes in contact both with foliage and root.

A plant, then, while building up by its own growth those organic materials which shall serve for the food of the animal, can make use of certain compounds only. The cycle of existence in which the inorganic world lends its materials to the

organising forces of vegetable life, and the structures thus built up serve for the sustenance of the animal—this cycle has a definite origin. In order that the cycle, or chain, which is continually repeating itself, should be able to do so, it is essential that the last term of this cycle should be a preparation for the first; that each substance which served as food for the living plant should be left in that particular and appropriate form when the life of the animal ceases, or should have been previously restored. So we may commence our inquiry into the special forms of material which constitute the food of plants at one end of the chain or at the other. We may ascertain what mineral forms the plant is feeding on, or we may investigate and detect the substances which the animal restores to the inorganic world during its life or after its death. By both methods we are led to the same conclusions, with some slight exceptions here and there—exceptions probably more apparent than real.

Beginning with the volatile elements of a plant, we turn naturally at first to the organic element *par excellence*, carbon. Dr. Hofmann, indeed, used to speak of organic chemistry as the "history of the wanderings of carbon;" and this aspect of the subject strikes us with peculiar force in the present inquiry. The oxidation of carbonaceous matter into carbonic acid CO_2, by animals, and the separation of the combined oxygen of this compound by plants, is one of the most important parts of the balance of animal and vegetable life, even serving to distinguish the higher forms, at all events, of the vegetable from those of the animal kingdom. Then, too, the large proportion in which carbon exists in plants marks it out as their most characteristic element. In round numbers, half the weight of a dried plant is carbon. Now it is pretty generally allowed that it is only in the form of carbonic acid that carbon is taken up by plants. All other carbon compounds, carbonic oxide and marsh gas, with the more complex substances containing this element, seem to be either useless or even actually injurious to plant life. The organic matters, for example, contained in peat and similar soil, rich in substances derived from plants, are generally hurtful to the growth of the higher forms of vegetable life. They contain carbonic acid, it is true, and they continually evolve it, and so far provide nutriment to the plant, but they contain in excessive quantity humus or organic mould. They are often said to be sour, and they do in truth contain acids, substances intermediate between the original materials of the plant and the final products of decay. These transitional compounds are always seizing oxygen, but are not yet sufficiently oxygenated to constitute plant-food, and they further interfere with vegetable nutrition by reducing to useless and

even injurious forms those substances, such as ferric oxide, which are in a suitable condition for assimilation. The injurious effects of decaying and putrescent organic matter in excessive abundance are more especially injurious when the soil is undrained and badly cultivated; for then the oxygen of the air and that dissolved in water reach these decaying substances in small quantities only and beneficially affect them but slowly. This point, concerning the true source of the carbon in plants being carbonic acid, and carbonic acid only, is further elucidated by two well known phenomena. The rich organic mud of ponds, saturated as it is with manurial matters, is yet found hurtful till it has been sweetened, that is to say oxidised, by exposure to the air. Then look at the effects of applying lime to such a soil as that to which we have referred. It neutralises the acids of the peat or humus, but it does more; it favours the oxidation of these bodies, and thus restores in a rapid and marked manner fertility to the soil. All that we have said on this subject of carbon (and we might have added many more experimental proofs of our assertion) is to illustrate these two points: that carbonic acid is the only form in which plants can take up carbon, and that carbonaceous matters during their decay are sources of carbon only as their carbon gradually oxidises into carbonic acid. These carbonaceous matters have indeed quite another function to fulfil in the soil, but with this we are not now concerned. And carbonic acid itself acts also in many other ways than as a plant food; for its chemical and physical actions upon the soil are of the very highest importance. We cannot here find space to do more than enumerate the sources of carbonic acid: such as the respiration of animals, the combustion of coal and other fuel, and the products of the volcanic and other chemical actions going on within the crust of the earth and upon its surface. The carbonic acid from all these sources does not accumulate in the atmosphere beyond the proportion of 4 parts in 10,000 of air, for it is continually withdrawn by the action of vegetation. But in the interstitial air of the soil itself a much higher proportion of carbonic acid is reached; often more than 1 in 100; while oxygen is proportionately deficient. So also the water penetrating through a soil, as well as the atmospheric moisture falling upon it, is rich in this gas.

We need not linger in speaking of the sources of hydrogen. In rain, dew, and mist, and in the water always present, dissolved in the atmosphere, we have the chief if not the only source of this element. Not only is water the form in which the element hydrogen must be presented to the plant, but water itself and the elements of water, in the proportion in which they combine to form water, enter into the constitution of most plant products. Starch, for example, not only contains hydrogen and

oxygen in the proportion in which they form water, but it always has two atoms of water of hydration present in it as well. But like carbonic acid, water has a double function to fulfil; it is the liquid medium by which the food of plants is absorbed, and in which the chemical transformations occurring in the plant are effected. Enormous supplies of water annually descend upon the land; if the rainfall be but 20 inches per annum this corresponds to something like 2,020 tons of water falling every year upon each acre. Much of this reascends by evaporation or is carried away in drainage; still, a large proportion is retained by a growing plant, or passes through it, fulfilling various necessary offices therein. It has been estimated that a gallon of water passes through a single plant of barley during its few months of growth, and that the aqueous exhalation of a blossom of the common sunflower is to be reckoned by many ounces in a single day.

The element oxygen is contained in nearly all, perhaps in all, the ingredients of plant food, so there is no need to describe the many sources of this element as a constituent of vegetable nourishment. Carbonic acid, water, nitric acid, sulphuric acid, phosphoric acid, all contain it in abundance: indeed, the function of vegetables is rather to return this element in a pure condition to the atmosphere than to feed upon it. In fact, although they do assimilate some quantity of it into other forms of combination than that of water, yet the proportion of oxygen in plant products is always less than in the average of plant food.

The fourth element, sulphur, is obtained from sulphates. Although the sulphur of plants is chiefly left in the form of sulphates when they are burnt, the sulphur of a plant is by no means wholly present as sulphates in the living organism. In the albuminoids of a plant unoxidized sulphur exists, and there are whole orders of plants characterised more or less distinctly by the presence of sulphuretted oils. The calcic sulphate and the alkaline sulphates which are constantly found in fertile soils generally supply this element, sulphur, in abundance and in an available form.

The next element is nitrogen. Of this it is commonly supposed that there are two sources, ammonia and nitric acid; but it is probable that all ammonia becomes oxidised before assimilation by the plant. All other plant foods are either oxygenated compounds or contain other characteristic non-metals, such as chlorine, or strongly chlorous radicals, such as that of the sulphates; it is not likely that ammonia, NH_3, is an exception, and that this hydrogenated compound, destitute of oxygen, is really a source of nitrogen. Free nitrogen indeed cannot be assimilated —such an idea is negatived by most of the exact experiments

which have been performed in this direction, but also by analogy; no free element, save perhaps oxygen, being assimilable. Ammonia, as well as nitric acid and nitrous acid, is however present in rain, river, and well waters, more or less constantly; but then we know that ammonia in the soil is rapidly oxidised, and that the conditions to which it is there subjected are such that it can hardly reach the plant in an unoxidised state. The total atmospheric nitrogen compounds reaching the earth in rain is very variously estimated, and seems to be by no means a constant quantity. But it must be remembered that dew and mist and fog, as well as the atmosphere itself, contain the three nitrogen compounds before mentioned, and that no attempt has been made to estimate simultaneously all the atmospheric nitrogen compounds whenever occurring, for a whole year: the difficulties of the task are indeed enormous. But until we have further information on this point it would be rash to affirm that our supplies of nitrogenous atmospheric compounds are always more than sufficient for the normal and natural condition of vegetation where nothing is finally removed from the soil. One thing we know: that an increased supply of nitrogen is often most effective in promoting vegetation, more conspicuously rapid and effective indeed than the proportionate addition of any manurial matter, even when all the other conditions of the experiment are suitably adjusted. Recent experiments have moreover shown that whatever may be the form in which nitrogen is directly assimilated, indirectly plants may derive it, not only from nitrous acid, and of course from nitrites, but also from ammonia and from most nitrogenous compounds. Uric acid, urea, and gelatine, can all contribute it with nearly equal ease and rapidity to the living plant. Even wool, so difficult to alter, so insusceptible of change, yet gives up, in course of time, its nitrogen in an assimilable form. One important difference between ammonia and nitrates ought to be here noted; ammonia, as long as it remains unoxidised, is retained in ordinary soils very firmly; nitrates are not. Then too, soon after a field, say of wheat, has been "top-dressed" in the spring with ammonic sulphate, a marked increase in the amount of nitrates in the drainage water of the field has been observed; a circumstance pointing at once to the ready oxidisability of ammonia and to the ease with which nitrates (chiefly calcic nitrate) are washed out of the soil.

We turn now to the ash, or non-volatile constituents of the plant. Of the oxygen, the sulphur, and the carbon found in part in the burnt residue of vegetables, we have already spoken, but among the non-metallic ash elements there remain four still to be considered: phosphorus, silicon, chlorine, and fluorine. The singular importance of phosphorus among these

warrants us in giving it a first and foremost place. Agriculture has long recognised the special value of phosphorus in the form of phosphates. This element is present but in small quantity in most soils, even the richest; 0·3 per cent. of total phosphates being rather a high percentage, though some soils of exceptionally phosphatic origin may contain as much as three parts of these compounds in 100 parts of soil. Phosphorus, like the elements previously discussed, is probably only assimilated in its most highly oxygenised form, that of phosphoric acid or a phosphate. The phosphates existing in a soil are those of aluminium, iron, and calcium; all very nearly insoluble in water, one part of the last-named salt, tricalcic phosphate, requiring no less than 100,000 parts of pure water for solution, though it is soluble to a considerably greater extent in the carbonated water existing in a fertile soil. The special need for extra supplies of phosphates under our system of agriculture is clearly explained, when we consider not only the comparatively small proportion of these compounds usually present in soils, but the steady drain upon these supplies in the enormous quantities of phosphates taken off the land in the shape of animals reared and sold for food, in milk, and in corn. We cannot here discuss how far these losses are replaced in the course of legitimate farming, but the temporary removal from the soil of such large quantities of a compound therein present in but small proportion—a proportion, so far as it is available, verging close upon the necessary minimum—this removal is, we say, a matter of great interest. This interest in part rests upon the distribution of phosphoric acid in the different parts of plants and animals, and its remarkable migrations within them. Though we cannot here enter upon this subject, we may cite one fact concerning the special relation of phosphoric acid to the constitution of the seed. For example, we may take the wheat plant; here the ash of the straw contains only 2·75 per cent. of phosphoric anhydride, P_2O_5, while the ash of the grain contains 46·79 per cent. But if you suppress at an early stage the development of the seed, the straw is proportionately enriched with this compound. So also with perennial plants; suppression, from accident or influence of season, of the formation of seed or fruit, often causes the separation in the tissues of a tree of phosphatic crystalline deposits, which have been recognised in teak and other woods. Other causes may indeed conduce to this result, but the reason we have named affords generally sufficient explanation.

Silicon occurs in the ash as silica and silicates. It is probably assimilated in the form of silicic acid, which in some of its states is soluble to an adequate extent in water, and is present in all soil. The ash of wheat straw contains nearly 62 per cent.

of silica, and there is even still more in that of some species of equisetum; while in some grasses, as the bamboo, it even occasionally occurs in a separate crystalline form.

Chlorine is probably assimilated by plants as sodic chloride or common salt: a substance which is most widely distributed over the surface of the earth, although the proportion in which it occurs in some soils is but small.

Fluorine, we have before said, generally accompanies phosphates, and it is most likely that calcic fluoride is the combination in which this element is supplied to plants.

Looking generally at the whole group of non-metallic elements found in plants, we see that with the exception of chlorine and fluorine, they are supplied as oxygen compounds. Taking the chief of these compounds, we find that they are the very forms into which animals are finally resolved after death; thus illustrating the truth of our position wherein we stated that in the circulation of matter the mineral is wrought into the vegetable, the vegetable into the animal, and this finally relapses once more into the original simple forms of inorganic nature. Here is a list of the names and formulæ of these final products of animal decay, which are at the same time the very materials of vegetable nutritive increase; we write these compounds in their anhydrous condition:—

Carbonic acid or anhydride	CO_2
Sulphuric " "	SO_3
Phosphoric " "	P_2O_5
Nitric " "	N_2O_5
Water	H_2O

Of the six metals invariably occurring in plants, potassium is usually present in larger proportion than any other. Calculating the potassium found in plants into the form of potassic oxide, K_2O, it rarely forms less than 20 and often more than 50 per cent. of their ashes. In the ash of roots and tubers the latter proportion is often found, while in seeds and grasses it is also abundant. The straw and chaff of cereals and the leaves of most plants contain it generally in smaller proportion, although there are exceptional cases; poppy seed, for example, yielding an ash containing only 12 per cent. of potassic oxide, while the ash of poppy leaves has more than 37 per cent. As to the form in which potassium is assimilated by the plant, it is generally believed that all neutral salts of this metal are indifferently taken up. Potassic chloride, nitrate, and sulphate have all been found in certain samples of fertile soils; and in some experiments, at all events, when these salts have been used as manures, an increase of potassium has been found in the crops. Still although soils generally contain what one would fancy to be little more than the necessary minimum of available potassic

compounds, the application of these salts usually causes a very moderate addition, if any, to the produce of the land. A good fertile soil has been known to contain only ·09 per cent. of potassic oxide, and yet to receive no benefit from further supplies of potassic compounds. But that this particular soil was becoming poorer and poorer in potassic oxide was seen by the analysis of the subsoil at a depth of 18 inches, which was found to contain ·29 per cent. of this compound. All good soils have however a singular power of retaining potassium compounds—a power which they do not possess to an equal extent with regard to the corresponding sodium salts, which are required in much smaller proportion by most plants. This retentive power for potassic compounds is shown by the relatively greater proportion of sodic salts carried off from cultivated land in the drainage water, even where the soil contains less of this sodic salts than of the potassic. Cultivated plants have been observed to contain more potassium than the same species when wild. The ash of wild asparagus, for instance, contains only 18·8 per cent. of potassic oxide, but 50·5 per cent. is found in the ash of the same plant when in a high state of cultivation and development. The preference which most plants have for potassium over sodium is illustrated by a study of the ash analyses of plants grown in soil almost destitute of the former metal and containing abundance of the latter; the potassium in these plants, spite of its small proportion in such soils, greatly outweighs the sodium. Even the sea, which contains 30 times as much sodium as potassium, furnishes to some of the algæ drawing all their mineral matter from it equal quantities of these two metals, and to many others half as much potassium as sodium. Experiments on land plants have shown that sodium can replace potassium only in some cases, and then usually only to a very limited extent.

Calcium occurs in the soil as carbonate, sulphate, and phosphate. Calcic carbonate and phosphate are very slightly soluble in pure water, but the carbonic acid water of the soil dissolves them both very readily. Calcic sulphate only requires about 430 parts of water for solution. Magnesium occurs in similar salts to those of calcium, and both metals are also sometimes present as silicates. Calcium occurs in small quantity in seeds, in large quantity in many stems and straws. Ash of wheat grain contains but 1·15 per cent. of lime, wheat straw 7·42 per cent.; ash of peas contains 4·78 per cent. of lime, the ash of pea straw, 37·17 per cent. Magnesia is present to the extent of 13·39 per cent. in the ash of wheat grain.

Iron and manganese may be considered together. Both metals are probably present in the majority of plants, and when there is abundance of iron then the manganese generally exists also

in weighable quantities. The proportion of manganese in plants is probably seriously influenced by that in the soil; it is a variable quantity. But little is known of the forms of combinations in which iron and manganese exist in plants, but they are usually found in the soil, if it be a really productive one, in the form of ferric oxide, Fe_2O_3, and manganic binoxide, MnO_2. It is well known that many unoxidised or partially oxidised compounds of iron, when present to a large extent, are injurious to plants, even to the extent of causing absolute sterility. Such combinations are iron pyrites, FeS_2, magnetic oxide of iron Fe_3O_4, and ferrous oxide and sulphate, FeO and $FeSO_4$.

Of the rarer metals, cæsium, rubidium, copper, &c., which have been recognised in the ashes of certain plants, we have already spoken. It is probable that in the course of careful inquiry in this direction we may discover other metals, the presence of which is as yet wholly unsuspected.

REVIEWS.

CONTAGION EXPLAINED.*

OF all the great questions which medical science has from time to time laboured to answer, there is none at once so entangled or so desirable of solution as that of contagion. The reason why the diseases included in the class "zymotic" spread from one human being to another, till at last a whole community is plague-stricken, is one in which every one finds an interest, some from selfish, some from philosophic motives. It behoves us, therefore, to consider with discrimination unmixed with passion, every effort which is made to explain this problem, which the whole world attempts to solve. The task of judgment is, too, all the more pleasing and less difficult, because of the number of side-lights, as it were, which fall upon the subject from the discoveries of scientific workers who have laboured in the vast fields of Chemistry, Physiology, and Hygiene. It is, therefore, with a full sense of what we owe to our readers, that we take up for analysis the last argument advanced in explanation of the extension of diseases by contact.

Dr. James Morris, having buckled on what he regards as a sort of syllogistic armour, attempts to apply Dr. Lionel Beale's law of the development of animal tissues to the ordinary doctrine of contagion, and thus to afford a rational explanation of the spread of epidemic disease—at least so we interpret his observations in the volume now upon our table. And, if we be correct in our estimation of the author's aim, we must say that Dr. Morris has occupied a considerable amount of space in telling us what he might have condensed into two or three pages. We would further remark, that he has laid down no principle which has not already been before the profession in various forms, and that he is certainly adopting a mischievous doctrinal method in basing an explanation upon an hypothesis which must even now be regarded as *sub-judice*. Briefly, the pith of Dr. Morris's teaching is this: All epidemic or contagious diseases are propagated by contact of a poison—which is assumed to possess vital powers—with the healthy tissues. This poison, like the molecules of nuclear matter, accumulates, and ultimately, under favourable conditions, gives rise to a sort of cell, which is composed of nucleus and primordial utricle—of germinal and formed matter—and which soon throws off small particles, which in their turn become similar cells, and thus spread through the infected organism. This is a definite proposition, containing, as Dr. Johnson said, a good deal that is true and a good deal that is new; but the new is certainly not true, and the true is by no means new. That in certain cases of contagious disease, the abnormal features

* "Germinal Matter and the Contact Theory." By James Morris, M.D., Lond. Second edition. London: Churchill. 1867.

which characterise the affection, are directly or indirectly the result of a foreign substance which has come in contact with the tissues, no one can for a moment deny. Clinical experience, analogy, and scientific experiment alike confirm this statement. In going further, and alleging that the poison is something vital, as distinguished from something physical—a distinction we by no means admit—the *onus probandi* falls upon him who makes the assertion. How then does Dr. Morris prove this part of his proposition? Only by telling us, in a by no means clear statement, which extends to about ninety pages, that Dr. Lionel Beale has found the germinal poison of vaccine and of rinderpest, and that he has proved it to be a vital substance. When and how, we beg to enquire, has Dr. Beale proved this? We are free to admit that Dr. Beale's examination of vaccine and rinderpest matter may have disclosed the presence in them of nuclear matter, and we will also allow that in the diseases of which the production of such matter is to some extent characteristic, that similar nuclear matter may be abundantly present; but surely Dr. Morris will not be so illogical as to force us to believe, as an ergo, that this nuclear matter, and this only, is the poison. A syllogism constructed in the fashion implied by Dr. Morris is open to many fallacies. For example, what is to prevent our supposing Dr. Morris's cause to be in itself only an effect? Is it not rational to assume, as at least a possibility, that the so-called "germinal" poison is associated with or consequent upon the presence of a purely liquid or gaseous poison which is one of the conditions of its existence? May we not assert with as much confidence as Dr. Morris, that in the case of, let us say the vaccine matter, this substance (vaccine) is composed of nuclear particles, surrounded by liquid and gaseous fluids — the latter being the cause and the former the effect? The one being an agent which acts in accordance with physical, and the other in obedience to what Dr. Morris would term vital principles. One has never yet been dissevered from the other. What right have you, then, to assign to one essential properties and to deny them as forcibly to the other? If you assert that your germinal particle is alone powerful, have you proved that the liquid matters in association with it are not equally potent? To illustrate the matter further, and as it were reduce Dr. Morris's argument *ad absurdum*, let us put it this way: We let fall a drop of sulphuric acid on the integument; destruction of tissue supervenes, and pus corpuscles are ultimately developed. Whence have these arisen? Have they resulted from a new set of physical conditions operating upon the Malpighian stratum of the skin? or are we to believe that they are the consequence of germinal particles which have existed in the sulphuric acid? The analogy is, we admit, a very coarse one between the phenomena in the supposititious case selected and those which follow contagion, but we think it will afford our readers some idea of the fallacy in the author's argument when examined by the simplest logical test. However, we have, happily, a series of facts presented to us in the researches of Dr. B. W. Richardson which justify our rejection of Dr. Morris's views, by showing that the phenomena of contagion with so-called "germinal matter" may be referred to purely chemical processes without evoking the aid of that eminently metaphysical muddle—"a vital principle"—which appears so congenial to our author's tastes. Dr. Richardson, it will be remembered, succeeded by certain processes in obtaining from pus a

chemical principle which represented its pyæmic properties. This, if we mistake not, was combined with an acid—as though it were a base—dissolved, and finally precipitated; nevertheless, the precipitate thus produced exhibited all the active poisonous qualities of the original pus, and when injected into the tissues of animals it gave rise to genuine pyæmia. How, according to the theory laid down by Dr. Morris, are we to explain these facts? We answer, in nowise. The results of Dr. Richardson's investigation, show us that a purely chemical substance extracted from an organised structure is capable, when taken into the system, of starting the development of the original *structure* from which it was obtained. Unless, then, Dr. Morris considers that Dr. Richardson's pus-salt contained his vital germs in chemical combination, we know not how to explain these facts upon his hypothesis. If this explanation be granted, then the whole problem becomes a physico-chemical one, and is removed from the category of so-called *vital* actions.

We have said sufficient to demonstrate the fallacy of the author's argument. The hypothesis laid down by Dr. Morris may still be true, but we think our readers will admit that its author has certainly not proved his case. The theory before us is stated in too many words. Had the author been more concise in expression he would have done more to inculcate his opinions, and he would have avoided certain contradictions which his observations exhibit. That his own ideas have been imperfectly developed is evident by what it seems to us is a confusion of terms, in which we find him occasionally indulging. Indeed, in one instance, we have been at considerable pains to interpret his meaning, but, unfortunately, our efforts have been unavailing. Alluding to the contagion of smallpox in Sydenham's days, he observes (p. 5), "Few escaped the disease, and these owed their immunity to the absence of *predisposition*, not to the absence of the virus." We are somewhat shocked to find a writer who aims at so high a position in medical philosophy thus explain a very remarkable phenomenon by employing a term which does nothing more than gloss over ignorance. It is therefore pleasing to find that the author, at page 37, thus defines predisposition: "When analysed, I think it amounts to saying that the enemy was within the body as well as without—that some of the specific germinal matter in question was circulating in the blood." This is, so far, satisfactory; but how, in the name of reason, are we to reconcile the somewhat distinct meanings which Dr. Morris attaches to the word predisposition? All through the work he aims at a show of sequence of argument, and adopts the somewhat clap-trap method of arranging his propositions in a fashion which may be taken by the uninitiated for syllogism; but in every instance where he tries his mental faculties on the really complex problems of physiology, he wades cumbrously and helplessly into the thickest mire of obscurity. This is evidenced in an especial manner by the strange notions which he seems to have formed on the subject of chemical forces; for he is good enough to tell those who have paid some attention to the chemistry of growth, that there is no correlation of the chemical "forces with growth." It may be surmised that by growth he means the other forces associated with growth; but perhaps we do an injustice in offering this conjecture. If we have thus noticed Dr. Morris's work at some length, it is because of the importance we believe due to

the subject it deals with, and by no means because we attach any value to the author's hypothesis, or to his skill in laying down his views. Such works as the one before us, being in reality the expression of foregone conclusions, are only calculated to trammel the cause of biological philosophy, and to impede scientific progress—upon the very principle which Dr. Morris argues for—by infecting healthy minds with the germs of obscure reasoning, imperfect grasp of subject, and shallow observation.

RAIN.*

WHO, if not Mr. Symons, is able to speak authoritatively on the various meteorological phenomena of rain and rain-fall? To him we owe nearly all that has been done in collecting rain statistics during the last few years, and to him we are indebted for the handy and clearly written little volume which has just been issued. As the title of the book indicates, Mr. Symons treats of the employment of rain-gauges. First he tells us how rain is collected. In this part of his work he describes the different forms of gauges now in use, and illustrates his descriptions by woodcuts of seven or eight varieties of the instrument. He dwells at some length on the subject of the receiving surface of a rain-gauge—should it be large or small? This is a *quæstio vexata* among meteorologists, and it has been a bone of much contention between the author and the *Mechanics' Magazine*, the former asserting that small rain-gauges are at least as good as large ones, and the latter advocating the opposite opinion. Mr. Symons gives the results obtained from the observations on the series of experimental gauges at Calne, and from these it certainly seems that the balance of evidence is in his favour, but really the difference is so extremely trifling, that it appears to us as if the combatants in the discussion were fighting for a shadow. The author gives some good practical advice on a point in which amateur meteorologists are much engaged, viz. "setting a gauge to work," which may thus be summarised. The mouth of the gauge should be made perfectly level, and so fixed as to remain so; the instrument should be set on level ground, and at a distance from walls, trees, shrubs, &c.; tall flowers should not be allowed to grow near the gauge. The gauge should be emptied daily at nine A.M., and the amount entered against the previous day. As the snowy season has begun, it is as well to give our readers Mr. Symons' directions for the estimation of snow-fall. There are three modes for doing this:—1. Melt what is caught in the funnel, and measure it as rain. 2. Select a place where the snow has not drifted, invert the funnel, and turning it round, lift and melt what is enclosed. 3. Measure with a rule the average depth of snow, and take one-twelfth ($\frac{1}{12}$) as the equivalent of water. On the subjects of when, where, and why rain is measured, our author is just as communicative of facts ascertained by practical experience and of suggestions which will be found useful by the student. But we have already quoted enough to show the value of his little work, and we must

* "Rain: How, When, Where, Why it is Measured." By G. J. Symons, F.M.S. London: Stanford, 1867.

now conclude our notice by recommending "Rain" to everyone who is interested in the now popular study of meteorology; they will find it a clear, straightforward guide to the accurate pursuit of weather-science.

THE MICROSCOPE.*

A WORK which is now in its sixth edition, and which the preface tells us has enjoyed a circulation of 50,000 copies, is really, by those very circumstances, carried beyond the province of the reviewer. It is only necessary, in noticing such a work, to say what features distinguish the present from the preceding issue. Mr. Hogg, whose position as Secretary to the Royal Microscopical Society, gives him no mean authority as a writer on microscopical subjects, has, in the volume before us, done his utmost to give a complete history of all recent progress in the invention and improvement of microscopic apparatus. There is, however, one exception to this statement, and we think, in common justice to his readers, Mr. Hogg is bound to afford an explanation of it. In the chapters devoted to an account of the microscopes of English manufacture, no mention whatever is made of the excellent and handsome instruments of Messrs. Beck and Beck. This omission is a serious one—it deprives the reader of information which in fairness he is entitled to receive, and it does a grievous wrong to one of our most eminent and respected firms. We have no desire to give Messrs. Beck any particular prominence; but we consider that the highest credit is due to them for their early efforts to popularise microscopic pursuits; and we trust, therefore, that, in his next edition, our author will not only avoid the omission in his present treatise, but will offer a fair excuse for the step he has, or rather has not, taken. Mr. Hogg's book is divided into two sections; the first dealing exclusively with the microscope, in its manifold shape and form, and with the several contrivances which are employed as accessories in preparing, mounting, and illumining objects; and the second treating of the objects which afford an interesting study to the amateur. Among the novelties in the first portion of the work, we notice a very elaborate account of the Browning micro-spectroscope; an instrument to which attention has recently been called by the researches upon cholera conducted with it by Dr. Thudicum, and made public in the Ninth Report of the Medical Officer to the Privy Council. Here, *en passant*, we may remark that Mr. Hogg quotes *ad libitum* from Mr. Sorby's article in this Review,† without giving us the merit which is due to us; an omission, however, which we have no doubt was purely accidental. The second division of Mr. Hogg's volume is really a treatise on microscopic biology, since it embraces detailed descriptions of nearly all the living structures whose characters are best observed with the aid of the microscope. There are in this, however, two points on which we must join issue with the

* "The Microscope: its History, Construction, and Application.' By Jabez Hogg, F.L.S., F.R.M.S., Secretary to the Royal Microscopical Society. Sixth edition. London: Routledge. 1867.

† P.S.R., January 1866.

author—one is a matter of fact, the other is one of opinion. Perhaps we are too critical, but it appears to us that the author's classification of animals is singularly faulty. Mr. Hogg gives an arrangement of the animal kingdom, which he says is Mr. Huxley's, but which we doubt not the School of Mines Professor would be the first to repudiate. In this scheme, animals are divided into four *classes*—Radiata, Articulata, Mollusca, and Vertebrata; of which the first is made to include the Scolecida and Echinodermata, and the second to embrace not only the true Aunulosa, but also the Hydrozoa, Actinozoa, and Polyzoa! How Mr. Hogg arrived at this extraordinary mode of arranging the several animal classes we can only explain in this way:—In his "Elements of Comparative Anatomy," Professor Huxley has tabulated the *classes* of the animal kingdom; and in the table in which he groups them he contrives, by a plan not unusual among zoologists, to show at a glance the distinction between what our present knowledge defines to be the affinities of the classes, and what their affinities appeared to Cuvier's mind. Whoever Mr. Hogg employed to transcribe this scheme—it is creditable to Mr. Hogg that he should have desired to bring his book up to the time by consulting the highest and most recent authorities—fell into the error of confounding the two methods of classification, and so has produced a table which is neither Baron Cuvier's nor Mr. Huxley's, but a perfectly arbitrary, and most heterogeneous combination of the two. This we hope to see altered in the next edition. The second point refers to the author's views as to the nature of cancer. These we cannot discuss here; but we by no means admit their demonstration. Now that, as conscientious reviewers, we have said all the hard things we could of the work before us, let us add a word or two in its favour. It is, without exception, the most comprehensive book on the microscope in any language; it is filled to overflowing with illustrations—nearly every page displays a woodcut—and there are, in addition, seven or eight coloured page plates, drawn by one of our ablest scientific artists—himself an accomplished microscopist—Mr. Tuffen West. Mr. Hogg does not cater for the higher class of students, for he quotes frequently from the works of Drs. Carpenter and Beale. His book is exclusively for the amateur; and we have no doubt that as it has already developed and popularised a taste for microscopic pursuits, it will continue to be the amateur's handbook and companion to the microscope.

DARWINISM DEMOLISHED.*

WE will not do Cambridge the injustice of regarding the author of the work before us as a type of its modern philosophers. Anything shallower or more pitiful than this feeble counterblast it has not fallen to our lot to be compelled to read. Not only does it display a most perfect ignorance of the evidence which has already been discussed by Darwinians and their opponents, but it lacks the ingenuity of the intelligent special pleader, and it is devoid of even the fascination of a scholarly style. Barren of argu-

* The Darwinian Theory of the Transmutation of Species, examined by a Graduat of the University of Cambridge. London: Nisbet, 1867.

ment and fact, it is a species of lugubrious howl against natural selection by a writer who, without the courage to declare his name, has yet the impertinence to attempt the demolition of a doctrine whose essential features he has, upon his own showing, been unable to comprehend. To analyse the assertions—arguments we can hardly term them—of such a writer, would not only be an indignity to the subject but would be a very questionable compliment to the intelligence of our readers. From beginning to end the author's observations are a prolonged and monotonous whine of complaint and querulousness. It has not even the merit of being a brisk bark, but is the monotone of puny helplessness which cannot understand, but which is capable of expressing its feelings only. If the author had simply stated at the outset that he had certain convictions (?) unbased on reason or observation, and that any system of philosophy opposed to these convictions must, in his opinion, be necessarily absurd, he would not only have given all his readers an insight into the species of ratiocination they had to expect, but he would have saved the thinker from the terribly unremunerative task of listening to his long cry of distress and misery. We yield to none in our admiration of the scheme of design, but we would ask whether the following sample of a Cambridge Graduate's reasoning(!)—bless the mark—is calculated to satisfy men who are determined to think for themselves, and who refuse to be led away from logical conclusion by mere florid declamation? Alluding to the Darwinian explanation of the origin of beauty—a theory, by the way, which in no way denies the teleological one, our author exclaims, "Poor miserable theory! which, quarrelling with creation, will not allow that the decorations of this terrestrial scene have been sketched and executed by a Supreme Intelligence, that sees beauty in its essence, and from that intention has turned out myriad graceful forms, tinted with refulgent colours, in well-considered contrast, or blended in perfect taste; and for all regions, and for every climate, has prepared endless varieties of elegance, attractiveness, and symmetry—a theory that will not allow an artist to have executed the picture, though it acknowledges its beauty, and so betakes itself to cocks and hens as a refuge from creation, and seeks shelter under a Metaphor to escape from Omnipotence." This elegant piece of composition is a sample of the whole book, and whatever its qualities as a merely literary production, we need hardly say it is not the species of refutation to prevent the spread of Darwinism. Indeed, if we wished to darwinise a thoughtful man, we should make him read this work as a preliminary to "The Origin of Species." We begin to think that after all this Cambridge graduate is a Jesuit in disguise, and has attempted a sort of *reductio ad absurdum* of orthodox views, with the object of encouraging Positivism. *Equo ne credite.*

NATURE'S LITHOGRAPHS.*

IF it be possible to convey to a child's mind a simple, and withal tolerably accurate, view of the great facts of geology, we think Mr. Steane's efforts

* "The Cabinet of the Earth Unlocked." By Edward Steane Jackson, M.A., F.G.S. London: Jackson, Walford, & Hodder. 1867.

come nearer the mark aimed at than any we have yet observed. There is a charming simplicity of style in this little book, which cannot fail to develop an interest in the teachings of nature in the minds of the little folk to whom its pages are addressed. The Second Master of the Tettenhall Proprietary School has a very happy method of explaining away the difficulties which geological problems are calculated to suggest to the youthful mind; and if, in the course of his every-day duties, he displays the same aptitude in popularisation, we can only say that his pupils are lucky indeed in the possession of such a teacher. Starting at that point in geological chronology at which the earth is supposed first to assume its present spheroidal outline, Mr. Steane leads his little pupils through the several stages of the world's history, up to the period of the mammoths and the hyæna caves. In describing the typical varieties of fossil forms, he invariably employs untechnical names, most of which are original; and as they are direct translations of the roots from which the scientific terms are derived, they deserve to be generally used by popular writers. Of examples of this species of vernacular terminology, we may give the following :—The Wing-fish (*Pterochthys*), Berry-bone (*Coccosteus*), Wedge-leaf (*Sphenophyllum*), Hand-beast (*Cheirotherium*), Gigantic dreadful beast (*Dinotherium giganteum*), &c. We think it a pity that allusion is made to the collision-points of Scripture and geology; but we suppose in the case of children there was no help for it; and, under the very difficult circumstances of the case, Mr. Steane has adopted the ingenious modes of conciliation which have from time to time been suggested by writers on Science and Theology. On the whole, we have to speak in high terms of praise of the author's labours, and we cordially recommend his book to all little folk who desire to understand the nature and significance of fossils.

SUN-VIEWS OF THE EARTH.*

WE have been taught by experience to regard Mr. Proctor not only as one of our best popular writers on Astronomy, but also as an earnest student of the heavens, and we are always glad, therefore, to have a new work announced as from his pen. The pleasure with which we heard of the issue of a new work by him has been fully justified by the character of the work itself. There is a peculiarity about the essays of this author which deserves to be noted. In all his books, Mr. Proctor aims at removing those stumbling-blocks which beset the ordinary student's path. The difficulties he has himself had to encounter, he strives to obviate or diminish for future workers. This is a great point, and if we mistake not, it is one very fully appreciated by the large class of amateur star-gazers. We believe that the attempt made in this last work of Mr. Proctor's will be as successful as that made in the publication of his excellent star maps, and we shall be much surprised if both professional and *dilettante* astronomers do not find these Sun-views of the Earth of the utmost service in facilitating their observations. The author

* "Sun-Views of the Earth; or the Seasons Illustrated, &c." By Richard A. Proctor, B.A., F.R.A.S. London: Longmans. 1867.

has here given us no less than forty-eight views of the earth as supposed to be seen from the sun at different hours and seasons, and he has also prepared five enlarged sun-views of England, and a diagram representing the earth's daily motion in her orbit. The figures of the globe are drawn in slate-colour on a black ground, the continents being mapped out in brown. The fact that the figures are as true for a hundred years hence or a hundred years ago, it is unnecessary to point out to our astronomical readers. The pictures hitherto published have been of a very imperfect and limited character; but Mr. Proctor's have been prepared with an accuracy which must have entailed no small amount of calculation. The book is accompanied—at least the copy forwarded to us is—by four quarto charts, which still further display the immense pains taken by the author to lay down a "royal road" for the amateur. These are (1) a chart of the Zodiac; (2) a chart of Mars, showing its different appearances at different periods of the year; (3) a scheme of the orbits of the Earth, Mars, Venus, and Mercury; and (4) a corresponding diagram of the rotations of the orbits of Neptune, Uranus, Saturn, and Jupiter. In the name of the world of amateur astronomers we publicly thank Mr. Proctor for his labours in the cause of Popular Science.

THE WORCESTERSHIRE FLORA.*

THE elaborately prepared flora which Mr. Lees has presented to the Worcestershire club, is a perfect model of what a work on local Botany should be. It is not too much to say that the author, who is a provincial botanist of no mean repute, has shown us what a flora should be. He has not simply given us a cut-and-dry list of the plants of his county such as we too often meet, but he has touched upon all the collateral points of interest which the botanist, who is not a mere dry-as-dust collector, should carefully consider. The distribution of plants in surface and in height, the relation of plants to soil and climate, the contest of families of plants for the tenancy of particular localities, and, finally, the separation of the indigenous from the introduced species, are all matters to which Mr. Lees has given attention, and on which his book is full of sound information. The author expresses his opinion clearly and forcibly in regard to the distribution of Worcestershire plants, and he occasionally gives Mr. Watson "a rap on the knuckles" for certain assertions in his *Cybele Britannica.* Mr. Watson doubts that the *Cynoglossum sylvaticum* is to be found in his "Mid-Severn Sub-Province (Worcester, Hereford, and Warwick); and for this scepticism our author takes him to task, and cites numerous authorities to show that Mr. Watson's extreme caution is unnecessary, and to prove that the species was several times found even in Worcestershire. Of course to the general reader there is not much of interest in the flora of Worcester; but to students of plant distribution and to local botanists, its carefully prepared lists, its plant-lore, and its excellent maps, will be heartily welcome.

* "The Botany of Worcestershire; or, the Distribution of the Indigenous and Naturalised Plants of that County, &c." By Edwin Lees, F.L.S., F.G.S., Worcester. Printed for the Worcestershire Naturalists' Club, 1867.

SCIENCE GOSSIP.*

THE volume for 1867 of this excellent Natural Science periodical has just been issued, and we confess that it astonishes us by the multitude of its first-class papers on Botany and Zoology. Not only do we find in it gossip in the strict sense of the word, but in addition there are essays which, while they are intelligible to anyone of ordinary education, would do credit to publications of a much more pretentious character. Though we may be accused of adopting the very threadbare phraseology of the newspaper reviewer, we are bound to say that it is a work which should be on every naturalist's library shelves. Wherever we dip into its pages we see something which fastens our attention and instructs our mind; something which recalls old subjects and familiar observations, and something which suggests new fields of interesting and profitable research. To give a detailed sketch of its contents we have not sufficient space, but we may direct attention to two or three articles which are especially worthy of the naturalist's notice. These are— "On Poduræ," a paper full of illustrations, and originally read before the Quekett Club, by Mr. S. J. McIntire; "How to study Natural History," a lucid *exposé* of Professor Huxley's celebrated lecture on the Morphology of the Annulosæ and on the Methods of Studying Natural History; "Leaf-boring Larvæ," by H. T. Stainton, F.R.S., the well-known entomologist, and lastly, "On the Disguises of Insects," by A. R. Wallace, a paper which, in importance of subject, clearness of expression, force of argument, and exposition of fact, is *par excellence* the Natural-History Essay of the year 1867. Mr. Cooke has given us a volume which accurately records the science of the year, and which is eminently creditable to his editorial skill.

HISTORY OF PHILOSOPHY.†

DR. STIRLING gives us a very satisfactory translation of Schwegler's condensed and useful "History of Philosophy," a work which, in the German, has gone through several editions, and has commanded a circulation of 20,000 copies. As our readers know, there is another translation extant of this treatise. It is published in America, and is the work of Mr. Seelye. The editor of the present translation, however, contends that he is justified in re-rendering Schwegler's book into English from the fifth German edition, which contains a variety of matter not to be found in the first edition, from which the American translation was prepared. Besides the reproduction of Schwegler's text, the editor has added several pages of his own annotations, which are certainly not the best part of the volume. The

* "Hardwicke's Science Gossip," an illustrated medium of interchange and gossip for students and lovers of nature. Edited by M. C. Cooke. London, Hardwicke, 1867.

† "Handbook of the History of Philosophy." By Dr. Albert Schwegler. Translated by James H. Stirling, LL.D. Edinburgh: Edmonston and Douglas, 1867.

various chapters of the work are devoted to biographic sketches of philosophy, from the pre-Socratic period down to the time of Hegel. If they were exclusively biographical and analytic, they would have served an excellent purpose, but they are pushed beyond mere analysis, and partake so much of commentary, that their value to the student who is indisposed to accept Herr Schwegler's opinions is greatly diminished. Still, the whole sketch of the progress of thought, from Socrates' days to the time of Hegel, is an interesting and instructive one. It is to be regretted that the editor did not attempt to bring down Schwegler's account, so as to embrace the writings of Mill, Spencer, Maudesley and others. An outlinear record of this kind would have been far more useful than the seventy pages of annotation which he inflicts upon his readers.

Organic Philosophy, Vol. II. Outlines of Ontology, by Hugh Doherty, M.D. London: Trübner, 1867.—Some two or three years since we had the misfortune to receive the first volume of Dr. Doherty's treatise, and in our innocence we read it. What the effect upon our mind has been we dare not disclose. Now the second volume is before us, and entails upon us another terrible labour. And here is the result we arrive at. The author has constructed an empirical philosophy, which he lays down in a language peculiarly his own. Dr. Doherty has not the faculty of reasoning logically from plain facts; nor is he able when he reaches the limit of reasoning—a limit in great measure the result of absence of fact, and therefore pointing to the necessity for more extended observation—to pause and say, thus far only can we go. So far from doing so, he soars away on the wings of his over-excited imagination, and allows his mental Pegasus to carry him into realms in which he loses all reason, and lays down with the most astounding dogmas in a manner which can only be satisfactory to himself. If we are ever to have a reliable system of philosophy, must we not reason to our conclusions step by step? How, then, can Dr. Doherty hope to found a philosophical scheme which shall be unimpugnable, when he writes in this strain: "Veneration may be compared with faith as solar gravitation and illumination may be compared with terrestrial attraction and reflected light. Organic faith is the force of stability in spiritual nature as the physical gravitation of the planets towards the sun and towards each other is the cause of stability in the solar system. As the sun attracts the planets so the Divine Spirit attracts all human spirits, whether they are conscious of the influence or not; and to say that prayer is useless because the *laws* of Nature are *immutable* is just as unnatural as to affirm that parents cannot listen to the supplications of their children and afford them succour without infringing natural or spiritual laws."

The Natural-History Transactions of Northumberland and Durham.—Vol. i. part iii. contains some valuable contributions to natural science, and seven or eight excellent lithographic page-plates, fully equal to those published in the Transactions of any of our Metropolitan Societies. Two of the papers are of considerable merit—"On the Excavating Sponges," by Albany Hancock, and on certain "British Entomostraca," by Messrs. Norman and Brady.

The New Science of Astronomy, as set forth in Chapter XII. of the Analysis

of Being, &c. By Joseph Wood. London, Farrah, 1867.—The author of this treatise starts from the portals of heaven, and terminates his (literary) career at the threshold of hell, and indeed travels so very far from the subject he has taken in hand, that we confess he has completely gone beyond the range of our limited comprehension.

Remarks on the Climate of Sidmouth. By J. Ingleby Mackenzie, M.B. London, Churchill, 1867—is a very honest and complete medico-meteorological monograph, in which we are told of the advantages and disadvantages of the climate of a favourite watering-place and invalid-resort.

Report of the Head-Waters of the River Rakaia. By Julius Haast, Ph.D. Christchurch, New Zealand, 1867. Published by Government.—This is just such a work as might have been expected from so able, experienced, and careful a geologist as Dr. J. Haast. It is an account of the head-waters of a river which is of considerable economic importance to New Zealand Colonists. The letter-press extends over seventy pages of folio, and contains tabular matter of a useful character, and a detailed account of the geology of the country explored. The map is drawn to show the mountain distribution, and the illustrations, twenty in number, are chromolithograph landscapes of a high artistic quality. They would do infinite credit even to Messrs. Day & Sons. Coming from a distant colony, they are an ample evidence of colonial civilisation.

Everybody's Year-Book for 1868. Wyman & Sons.—Is just what its title signifies, and is printed in that admirable style which characterises all the productions which emanate from Messrs. Wyman's press.

SCIENTIFIC SUMMARY.

ASTRONOMY.

Astronomical Events of the Past Year.—In his opening address at the first meeting of the season, in November last, the President, the Rev. Charles Pritchard, alluded to the progress of astronomy for the past year. Astronomical gains were not so conspicuous as in former years, but it must be remembered that astronomy was, like all other sciences, progressive, and its progress was necessarily slow; and although he had no new discoveries to bring forward as having occurred during the year, there was ample assurance that plenty of men had been at work; and when this was the case there was no doubt that, like bees gathering honey, observations of the greatest value would be made and stored up. In our present summary we propose to notice the principal astronomical events which have occurred during the year that has just passed; and while doing what we can to avoid the appearance of repetition in a few cases in which the subject has already been brought before our readers, we shall refer to some matters relating to the science which have not been alluded to in our last volume.

The Gold Medal of the Royal Astronomical Society was last year presented to Mr. Huggins and Dr. W. A. Miller (conjointly) for their labours in astronomical physics, and more especially for what they had done with regard to spectrum analysis, by which that process had been successfully applied in examining the nature and constitution of the heavenly bodies. In order to present the medal to two persons for the same work, the bye-laws of the society were at a former meeting suspended for this occasion. Some little discussion took place as to the propriety of this proceeding; but the meeting was unanimous in approval of the Council's award of the medal to Messrs. Huggins and Miller.

An Eclipse of the Sun, in which about three-fourths of the disk were obscured, took place on the morning of March 5. Near London the sky was more or less overcast during the progress of the phenomenon: nevertheless, a great part of the eclipse was well observed. In many places in England the whole was seen, the light clouds preventing the necessity of using dark glasses. Mr. Brothers, of Manchester, obtained some excellent photographs of the eclipse at the time of greatest obscuration. No traces of spots were observed on the sun on this occasion.

A Partial Eclipse of the Moon, in which more than half the surface of the disk was obscured by the earth's shadow, took place on the evening of Friday, September 13, and the night being cloudless, it was well seen by numbers of spectators. The first contact with the shadow occurred at a few minutes before eleven o'clock, and the eclipse terminated about two o'clock

in the morning. Much correspondence has taken place with reference to this eclipse, more especially with regard to the colour presented by the moon when under the earth's shadow—some stating it to be of a bluish, others of a coppery tint; while Mr. Browning, using silvered glass specula of large size, considers that the moon presented *no colour* during the phenomenon. A notice of this eclipse was given in our last volume, p. 445.

Occultations of Planets and First Magnitude Stars.—Two occultations of *Aldebaran*, one of *Venus* and one of *Mercury*, took place during 1867. Of the three first of these we have not seen any account, but of the latter, that of *Mercury*, an observation by Capt. W. Noble is recorded in the Monthly Notices of the Royal Astronomical Society. This occultation took place on May 1, about half-past one in the afternoon. The planet was wretchedly defined, the sky hazy, and the sunlight bright. *Mercury* seemed to fade away gradually; the moon's limb was utterly invisible.

Comets.—Three comets have been discovered in the year 1867, of which the following are the particulars:—Comet I., 1867, discovered at Marseilles, January 27, by M. Stéphan; Comet II., 1867, discovered by M. Tempel on April 3; and Comet III., 1867, discovered by Herr Baker, at Nauen, on September 27, and four hours later by Dr. Winnecke. These are all telescopic comets.

Minor Planets.—Three minor planets have also been discovered in the year 1867. To the first of these the name of UNDINA has been given; it is (No. 92) in the series of minor planets, but perhaps may claim a greater amount of notice, from being the *hundredth planet* of our Solar system. Undina has a magnitude of about 11·3, and is the sixth discovered by Dr. Peters, counting from Feronia, which he was the first to observe. His present discovery was detected just before daybreak on July 8, at the Hamilton College Observatory, Clinton, U.S. Planet (93) was first observed by Professor Watson, Director of the Ann-Arbor Observatory, on the 24th of August last, and it was the same indefatigable observer who discovered the last as yet perceived (No. 94), on September 6. These two planets are each about the 11th magnitude; no elements have as yet been published.

The Planet Mars arrived at opposition on January 10, 1867, the usual ephemeris of stars to be observed with him, for the purpose of determining the parallax, being given in the Nautical Almanac.—Observations and drawings of the physical appearance of Mars were made by Mr. Joynson, of Liverpool, who considers that "the dark band, or mark, round the planet is permanent, extending all round with but one narrow break. The colour of this band is generally dark green." Mr. Browning, of London, also made careful drawings of Mars at this opposition, and Mr. Huggins applied the spectroscope to the planet with valuable results—points which we noticed in our last volume, p. 311.

Periodic Meteor Showers.—The unusually magnificent display of meteors in November 1866, following as it did so closely the predictions of astronomers, caused more than the ordinary amount of attention to be given to the subject last year, and the August and November showers were anxiously looked for. In August, however, the display was very small; the night of the 10th, owing to the moonlight, being unfavourable for observing any but the larger ones. At Oxford, eighty-five were recorded from half-past ten up to three in the morning; other observers give numbers, more or less. Mr. Bir-

mingham notes that most of the meteors were tailless, although some had fine full disks and long tails (some notice of these will be found in our summary for October last, p. 441) like the November group. It was, however, the November shower which was expected with greater anxiety; although observers had been warned, by those well acquainted with this branch of astronomy, that the meteors were not likely to appear before five or six o'clock in the morning, and that the moonlight and approaching daylight would greatly interfere with any good observation of them. Unfortunately, however, on the morning of the 14th of November the sky was greatly overcast; and it appears, from observations made and the continual watch kept up in most parts of the country, that not above half-a-dozen meteors were seen. In a letter from Rome, Father Secchi states, that during a break in the clouds about six o'clock in the morning, a few meteors were seen; on the whole, however, the weather prevented any observations of the meteor shower, if it did take place at the time expected.

Observation of the Planet Jupiter without his Satellites.—At the meeting of the Royal Astronomical Society, December 14, 1866, the Astronomer Royal called attention to the fact that this rare phenomenon would take place in the following August. It will be recollected, that Mr. Proctor supplied a full and interesting detail of what was to be seen, at p. 248 of the July number of the *Popular Science Review*. It was, therefore, with much hope, not unmingled with anxiety as to the weather, that the evening of the 21st of August was looked forward to; and, although in few instances were the whole of the phenomena observed in any one place, owing to the passing clouds, yet, on the whole, expectations were gratified by a sight of the planet which may almost be pronounced unique. It was expected that possessors of moderate telescopic means would see the planet divested of his satellites, and with three black dots, or shadows, on his disk; while those who had more powerful instruments might, in addition, be able to detect the bright satellites also. But, to the astonishment of all, those using even quite ordinary telescopic power were surprised by seeing not only three, but five black dots!—the third and fourth satellites, on this occasion, appearing nearly, if not quite, as black as their shadows. Observations, carefully made in all parts of the country, confirm the occurrence, in this instance, of an anomaly with regard to the third and fourth satellites, which has often been noticed before, although not yet sufficiently accounted for. The fourth satellite particularly was seen projected on the planet as an intensely black spot; while on many occasions it is invisible, like the other satellites, from its brightness. This dark appearance of the satellite itself is also often the case with the third; never, we believe, with the first or second.

Suspected Changes on the Surface of the Moon.—This subject has, during the past year, remained somewhat in a state of abeyance, as to any definite conclusions to be derived from observations made upon Linné. It is admitted, that much uncertainty prevails as to the nature of the observations of former years, more particularly whether Beer and Mädler's measurement of the diameter (1·4 German miles) related to the crater itself, or to the whole bright patch, which appears now to be about that size. Continued scrutiny and careful attention are quite necessary, with accurate drawings, in order to form a base for future observations of change. The matter, however,

will be well watched by the Lunar Committee, whose last circular requests that observations of the large white spot should be resumed, with a view of ascertaining the state of the *large shallow crater*, and of the orifice (*small crater*) within it. Measures of the small crater should be made at least once in every lunation. Observations of the mountain, Gamma Posidonius, and of the black point on its summit, are also asked for.' There is work here for many of the powerful instruments now in the hands of amateurs; and Mr. Birt, who has devoted a large amount of attention to the lunar surface, recommends that each spot should be treated separately, with as much care as each binary star. Whether any real physical change may be discovered it is impossible to say, but that peculiar variations do take place in some craters more than in others, appears certain. If the inquiry should terminate in anything tending to show atmospheric action on the moon, the result would be a discovery of the utmost importance.

The Parallax of Sirius.—In a paper presented to the Astronomical Society at the last meeting, M. Cleveland Abbé has discussed the observations made at the Cape of Good Hope, between the years 1856 and 1863, with the object of obtaining a more accurate determination on this subject. The result of the investigations is corroborative of the conclusion drawn by Mr. Henderson, in vol. xi. of the Memoirs of the Royal Astronomical Society, that "the parallax of Sirius is not greater than half a second of space."

Large Object-glasses.—It was announced by the President, at the meeting of the Royal Astronomical Society on the 8th of November, that the large object-glass of twenty-five inches diameter, in course of working by the Messrs. Cooke of York, was at length completed; and that the severe test of dividing Gamma 2 Andromeda had been satisfactorily sustained by it. This is a subject quite worthy of notice in the list of Astronomical Events for the Year 1867, as the completion of this immense glass has been long and anxiously looked forward to. It must, however, be some time before it is in a position for its great capabilities to be made use of. We have, however, other glasses of great size; eight and nine inch aperture telescopes are now frequently to be met with, both in public and private observatories; but all are at present eclipsed by the telescopes used by Mr. Buckingham, of Walworth, who gave an account at the meeting of the Society above referred to of the discovery of some minute companions to *Vega* with a 20-inch aperture telescope, the object-glass of which, however, he had just replaced by one of 21¼ inches, both having been made by Mr. Wray, of Highgate. The discovery of these companions to Vega had been brought before the public previously in the *Astronomical Register*, a notice of which will be found in our summary for October last, p. 443. Mr. De La Rue stated that it was not only necessary to turn both the object-glass and the eye-piece round, but that the objects should be looked at when in different parts of the heavens, to guard against their being the production of flexure in the telescope tube itself.

The Late Earl of Rosse.—No name among those connected with modern astronomy is more widely known than that of Lord Rosse. To him the science is greatly indebted, not to his scientific or mathematical acquirements, but to the fact that he was one of those, rarely to be met with, who, having large means, devoted them liberally to the cause of science. Lord

Rosse's great telescope is a household word, as it were, with observers. To the uninitiated it represents something mysteriously powerful, while to those who are acquainted with the difficulties connected with instruments of such a size it shows what indomitable perseverance and energy can ultimately accomplish. Sir William Herschel's great reflector at Slough was four feet in aperture; the first completed by Lord Rosse was three feet; but he did not rest satisfied with this, and with enormous trouble and expense succeeded in bringing to perfection the great reflector of six feet aperture. In 1850 the results of this great undertaking were laid before the Royal Society. Lord Rosse's name as an observer is principally connected with the nebulæ, many of which, hitherto considered irresolvable, were broken up into stars by the great telescope at Parsonstown, while others, hitherto not distinguished by peculiarity, were found to possess the most singular spiral forms. Lord Rosse was born in 1800, and succeeded his father in 1841; he became President of the Royal Society in 1849. His death took place on the 31st of October last.

Lord Wrottesley died but a few days previously to the subject of our first notice, on the 27th of October, at the age of 69. He was one of the founders of the Royal Astronomical Society, and succeeded Lord Rosse as President of the Royal Society in 1855. His first observatory was situated at Blackheath, where he installed Mr. Hartnup, now director of the Liverpool Observatory, as his assistant. Here he completed a valuable catalogue of stars, for which, in 1839, he received the gold medal of the Astronomical Society. He established his observatory at Wrottesley in 1841.

Sir James South also died in the month of October last year, at the age of 82. In like manner one of the founders of the Royal Astronomical Society, he took the greatest interest in its early proceedings, and was some time its President. In conjunction with Sir John Herschel, he compiled a valuable catalogue of double stars, which is still a standard of reference, and has been extensively used in all works on the subject: a full description of the instruments used in the observations made for it is to be found in the *Philosophical Transactions* for 1825. At the time of his death, his observatory at Campden Hill was furnished with a variety of large and valuable instruments; and although his great age and increasing infirmities have caused his name to be little mentioned of late years, he took the greatest interest in astronomy up to the last.

BOTANY.

Effect of Electricity on Plants.—In a memoir quite recently presented to the French Academy, M. Blondeau—whose researches on the sensitive plant were chronicled in our last number—described the peculiar influence which, according to his experiments, the induced electric current exerts on the seeds and fruits of plants. In the case of the fruit the effects of the current were not so remarkable as in that of the seeds. It caused the former to ripen with greater rapidity than usual, but it produced very singular results when passed through the seed. Peas and grains of corn which had been electrified were placed in pots of earth, and beside them, and under like conditions,

were placed seeds which had not been acted on by the current. It was found that the electrified plants germinated much sooner than the others, and produced better stems and greener and more healthy-looking leaves than the others. A very curious effect was produced in some of the seeds—the stem and leaves grew down into the earth, and the roots came up and took their place.

Who discovered the Laticiferous Vessels?—It would appear from a letter which Herr Schultz has lately addressed to the French Academy that he considers he is entitled to some of the merit belonging to the discoveries of the latex vessels. Our readers will remember that from time to time we have recorded the various additions made to our knowledge of the laticiferous system by M. Tréeul, the great French botanist. Herr Schultz's letter is simply an attempt to deprive M. Tréeul of the credit of discovering these vessels. In fact, it denies M. Tréeul's right to be regarded as the discoverer of the latex canals. M. Tréeul replies to Herr Schultz's letter with great modesty. He states that he never dreamt of being regarded as the discoverer of the laticiferous vessels, which he says were investigated many years since both by Malpighi and Duhamel. He merely claims to have more thoroughly explained the nature and relations of these vessels than modern observers. To this claim of M. Tréeul's it is impossible to raise any objection. The numerous contributions recently made by M. Tréeul to the French Academy demonstrate three points in the anatomy of the laticiferous vessels which were hitherto surrounded with considerable obscurity:—(1) The structure and modification of the vessels; (2) their anastomoses with the fibro-vascular canals; and (3) the existence of latex in both the spiral and punctated vessels.

An Abnormal form of Ophrys.—In the *Journal of Botany* for November, Mr. I. J. Traherne Moggridge describes a curiously abnormal form of the ophrys which is worthy of notice. This subject had before received Mr. Moggridge's attention, for in the *Journal of Botany* for June, 1866, we find descriptions of other monstrosities in the same plant. In his first paper he described two flowers, in one of which a second anther was produced within the lobes of the normal one, and the other was a third rostellum on the edge of the stigmatic cavity at the point where the glandular processes in orchis seem to indicate the presence of rudimentary anthers. In the paper which he has recently published he adduces examples of different stages of abnormal development, all showing how the petal, when in connection with that part of the stigmatic cavity which sometimes produces a rostellum, is gradually modified into an anther. The specimens illustrating this process were collected at Mentone, and have been carefully figured in a page-plate which accompanies Mr. Moggridge's paper.

Polliniferous Ovules in a Rose.—The occurrence of polliniferous ovules in certain plants shows us how very careful we should be in drawing conclusions as to what is termed vegetable parthenogenesis. The fact of pollen-bearing ovules existing in a rose has been pointed out in a valuable contribution to teratological botany by Dr. Maxwell T. Masters. The most striking feature in the specimens examined by Dr. Masters was the occurrence on the throat of the calyx, in the position ordinarily occupied by the stamens, and sometimes mingled with those organs, of twisted, ribbon-like filaments,

bearing one or more pendulous anatropous ovules about their centres and on their margins; immediately above the ovules were the anther lobes, more or less perfectly developed, and surmounting these a long style, terminating in a fringed funnel-shaped stigma. Sometimes the ovules were perfect, at other times the nucleus protruded through the foramen, while in a third set of ovules the nucleus was included within the tegument, the ovules having in all respects their natural external conformation, but containing not only pollen-grains but also a layer of those peculiar spheroidal cells containing a fibrous deposit, which are among the normal constituents of the anther. In one case, where the coat of the ovule was imperfect, and thus allowed the nucleus to protrude, it was evident that the pollen was contained within the central mass of the ovule. In this instance Dr. Masters failed to see any of the fibrous cells; these he only found in cases where the coat of the ovule was perfect; and hence he thinks that probably the fibrous cells were part of the coat of the ovule, while the pollen was formed within the nucleus.—*Journal of Botany*, No. lix.

Astronomical Movements of Plants.—A somewhat peculiar paper has been published by M. Ch. Musset, in which the author endeavours to show that certain characters of the trunks of trees are related to the movements of the earth. The trunks of trees, he says, are always flattened in the northerly and southerly directions, and expand in an east and west plane. He states that he could support his theory by several thousand examples, and that his views are thoroughly in accordance with astronomical laws!

A Valuable Herbarium for Sale.—On the authority of M. Henri de Saussure, the *American Naturalist* states that a valuable collection of plants is now offered for sale. The collection of the Swiss botanist, the late M. Gay, is to be sold, and is said to be on view at the Jardin des Plantes, Paris. The price is fixed at 30,000 francs. The herbarium embraces the whole European flora. It contains 90,000 specimens, each specimen bearing a description and analysis.

Absorption of Carbonic Acid by the Roots of Plants.—It is so long since we had to record any work of M. Corenwinder in the department of physiological botany, that we are pleased to find him return to his researches in a paper read before the Academy of Science in November. M. Corenwinder states that he is induced to offer some remarks upon the rash statements of M. Boussingault relative to the functions of the root. M. Corenwinder gives it as his opinion that "plants have not the power of absorbing carbonic acid from the soil by their roots, or that at least the quantity which permeates the tissues from this source represents but a very small proportion of the total amount of carbon their tissues contain." Boussingault stated that in the air contained in an ordinary soil he found no less than ten per cent. of carbonic acid. M. Corenwinder asks what is the source of this large quantity of gas, and replies that it arises from the mass of decomposing organic matter, leaves, &c., which in the processes of agriculture and by the influence of worms, &c., become embedded in the soil. M. Corenwinder, however, does not say what becomes of this carbonic acid. Liebig and other chemists answer the question better, in showing that the carbonic acid is taken up by water which percolates through the soil, and that it is then used in eroding rocks and dissolving up otherwise insoluble mineral matters.

Industrial Use of Laminaria digitata.—An application of this large and very abundant species of sea-weed has been suggested in a paper read before the last Pharmaceutical Conference by Mr. Edward Stanford. He states that the stems of the tangle-weed *Laminaria digitata* when thrown up on the shore of the Hebrides are several feet long, and about as thick as the wrist, and when properly burnt they are converted into an excellent porous charcoal. This charcoal resembles that produced from animal matters, and has excellent properties as a means of filtering water. It has the following composition:—Carbon 50, phosphate of lime 4, carbonate of lime 20, carbonate of magnesia 6, silicic acid 5, alumina 2, sulphate of potass 5, chlorine and iodine 5.

A New Vegetable Parasite is reported to have been discovered by Dr. Beigel, the discoverer of the so-called "chignon-gregarine," *Pleurococcus Beigeli.* The new species has been found by Dr. Beigel upon the ear, and like that of the hair belongs to the algæ. It will be described in that treasury of scientific contributions the *Nova Acta.*

The Botanical Society of Canada is about to resume the publication of its "Annals." Botanists desirous of subscribing to this periodical may do so by paying four shillings annually. All communications are to be addressed to Dr. Lawson, Dalhousie College, Halifax, Nova Scotia.

The Laws of Botanical Nomenclature.—M. Alphonse de Candolle is engaged in the preparation of a new edition of his "Lois de Nomenclature." It will be published in English and German, the English being entrusted to Messrs. Lovell Reeve and Co.

Collection of European Plants.—In the *Journal of Botany* for November, the editor announces that Dr. E. Rostan, San Germano Pignerol, intends to dispose of his duplicates of European plants at 20 francs per hundred (where not less than one hundred species are selected). Botanists who desire to see the catalogue of about 6,000 species of vascular plants may communicate with J. Boswell Syme, Esq., 70, Adelaide Road, Haverstock Hill, London, N.W. Dr. Rostan has in preparation a catalogue of about 2,000 cellular plants.

What is a Weed?—Dr. Trimen, of St. Mary's Hospital, joins issue with Dr. Seemann on this point. He thinks it is impossible to give, as Dr. Seemann has done, a botanical definition of a weed which shall be unimpeachable. He considers, rather, that a weed is simply a plant in the wrong place, selecting such examples as *Ononis arvensis*, *Tussilago Farfara*, and *Euphrasia Odontites.* He says they are certainly weeds, and very troublesome ones, and also, we must believe, in the absence of any kind of evidence to the contrary, natives of this country. *Silene inflata*, *Stellaria media*, and *Veronica hederifolia*, seem to stand in the same category. There is no difficulty in supposing that such species have become weeds since the origin of cultivation, and as a result of it; that, in fact, the conditions set up by agriculture and gardening have furnished numerous localities highly favourable to their growth. In fact, a plant is a weed only in virtue of its situation; it may be an ornamental or even a useful plant *in its place*, but out of that place it becomes a weed. A Sunflower in a field of turnips is as much a weed as *Brassica Napus* in a flower-garden, but reverse their situations and the term is inapplicable to either. So when waste land, such as heath, is

enclosed and brought under cultivation, the species composing its original flora become weeds in the new fields.

Plants within Plants.—The discovery which M. Trécul some time since announced, of the existence of minute vegetable organisms within the starch-cells of *Helianthus tuberosus,* and to which he gave the name of Amylobacteria, has been regarded by him as a decided proof of the spontaneous generation of plants. Thus, although the doctrine of heterogeny has lost its main advocate by the recent recantation of M. Al Donné, it has found a new and powerful ally in the person of M. Trécul, one of the most eminent botanists in France. M. Trécul defines vegetable heterogeny to be "a natural operation by which life, when about to abandon an organised body, concentrates its action in some of the particles of this body, and converts them into beings quite distinct from those they proceeded from." We do not admit the logical force of M. Trécul's argument so long as it is admitted by physiologists as proven that vegetable forms of the lowest type may enter the tissues of animals. There is no more wonder in the fact of a cholera-fungus in the blood of man than in an Amylobacterium in the starch-cell of a *Helianthus tuberosus.*

Movements of Minute Green Organisms.—In a most interesting paper on the movements of microscopical plants, which is translated in the last number (October) of the *Quarterly Journal of Microscopical Science,* Professor F. Cohn gives us the result of his careful observations of the peculiar rotatory motion of the lower vegetable organisms and of the relation of this motion to the influence of light. The paper contains so many important details, that we must refer our readers to it for fuller information. We may mention, however, that Professor Cohn, who shows that light causes these microphytes to move in a definite direction, gives this explanation of the phenomenon:—"If we consider these facts concerning the movements of organisms which possess a green and a colourless half in connection with the property of chlorophyll to effect, through the agency of actinic rays, certain chemical actions—in particular the decomposition of carbonic acid and the separation of oxygen—it appears probable that all these phenomena of movement, as far as concerns their direction being caused by light, depend upon the chemical activity of these bodies. We can, in fact, imitate, by pure chemical processes, with the help of what may be called an artificial Euglena (namely, a fusiform fragment of chalk, half of which is covered with a resinous cement, and which is placed in diluted sulphuric acid), many of the phenomena recorded above. The splinter of chalk develops oxygen on its uncovered half, and is thereby projected by the backward impulse in the direction of the covered end, and is caused to rotate."

CHEMISTRY.

The Atmosphere of the Underground Railway.—Most of our readers are aware that the evidence of the Chemists, Messrs. Letheby and Rodgers, who examined the air of the Underground Railway, led the jury to return a verdict to the effect that the atmosphere of the tunnels was not dangerous to health. In this verdict we cannot agree, however legally accurate it may

be. We believe that the air examined by the chemists in question was taken from the tunnels after several thousand square feet of opening had been made, to allow the foul gases to escape; and if this view be correct, of course the analyses presented to the court were practically valueless, so far as they represented the atmosphere by which the death of the woman on whom the inquest was held was correct. Then again we find that our well-conducted and cautious contemporary, the *Chemical News*, is quite dissatisfied with the manner in which the analyses of the air were carried out. In an editorial article of some length, the writer states in reference to the discrepancies in the evidence—"We have here two views of the case, not agreeing very well with each other, although not in all points contradictory. Both, however, agree in drawing conclusions favourable to the air of the railway. *For ourselves, we are unable to draw any such satisfactory conclusions; the analyses are not clear.* Are we to look on the average air as containing only five or six parts of carbonic acid per 10,000, or are we to consider that it has lost seven or eight tenths of a per cent. of oxygen, which would indicate a larger amount of carbonic acid? Or, again, are we to believe that there is too little sulphurous acid to do us injury, or five times more than is needful to make us cough? All these questions still remain unanswered, and yet the companies are believed by many to have made an excellent case."

A New Test for Alkalies is said to have been discovered by Herr Böttger. Indeed the test is supposed to be applicable to both alkalies and alkaline earths, and is based upon certain changes of colour produced by these elements in the colouring matter of the leaves of *Coleus Verschaffeltii*. The re-agent is prepared by digesting the fully-developed leaves of this plant in alcohol, and impregnating slips of Swedish filtering paper with the solution obtained. This test-paper is of a beautiful red colour, which becomes green under the influence of an alkali or alkaline earth. It is not affected by free carbonic acid, so that it may be used for detecting traces of carbonate of lime in water.—Vide *Jour. Soc. of Arts*, Nov. 22.

Solubility of Iodine in Organic Substances.—According to a paper read before the Vienna Academy of Science, by Herr Hlasiwetz, iodine is extremely soluble in many organic substances. It dissolves to a considerable extent in aqueous solutions of resorcin, orcin, or phloroglucin, without imparting to them any colour. These solutions may be boiled without iodine being volatilised; they have almost neutral reaction, and starch, or carbonic bisulphide, does not indicate free iodine. A solution of the latter in alcohol or carbonic bisulphide is decolorised by adding one of the organic bodies mentioned, which may therefore be used in place of sulphurous acid in volumetric determinations by means of iodine. Other organic substances have been observed to behave in a similar but less decided manner.—*Akad. Wien*, 231, 1867, and *Chemical News*, Sept. 29.

Estimation of Organic Matter in Water.—M. Bellamy recommends as a rough but tolerably accurate mode of calculating the quantity of organic matter present in water, the use of sub-sulphate of alumina. When this re-agent is added to water which contains organic impurity, a precipitate is thrown down which is of a triple nature, being due to the influence of the quantity of water, of earthy bicarbonates, and of organic matter. The latter is deposited in a few hours, surrounded by the alumina with which it has

combined. He conducts the process in a graduated tube, and considers that the height of the deposit gives a fair, though rough, indication of the proportion of organic matter present.

The Chemistry of the Tannic Acids.—Herr Hlasiwetz has published the second part of his memoir on the tannic acids, in which he treats of the tannic acids extracted from Jesuits' bark and male-fern. When these acids are submitted to the action of dilute mineral acids they give rise to the production of sugar and of some other undetermined product of decomposition. Hence, from this point of view they behave in a manner similar to the Glucosides.—Vide *L'Institut*, Oct. 9.

The new Laboratory at the Sorbonne.—This magnificent establishment, which is to be devoted to the pursuit of chemical investigation, seems to provide for the student's wants on even a more liberal scale than its celebrated rival at Berlin. Besides the various rooms for researches in chemistry, *pur et simple*, there are numberless apartments exclusively intended for investigation in optics, electricity, mechanics, and so forth. Motive-power is provided for by a steam-engine of great force, which is connected by means of bands with wheels in the several laboratories. Again, besides the ordinary pipes carrying coal gas, there will be a series of pipes supplying oxygen from retorts kept constantly at work. Indeed, altogether the New Laboratory will be a species of Elysium for the chemical investigator.

The Absorptive Action of Soils.—At the meeting of the Chemical Society on November 7, a paper was read by Mr. Robert Warrington, jun., in which the author treated of the part taken by oxide of iron and alumina in the absorptive action which soils exhibit. Experimenting with the artificially prepared hydrates of alumina and ferric oxide, as well as with two samples of native soil containing widely different amounts of the same ingredient (or rather, "oxide of iron and alumina" 6·82 and 19·31 per cent. respectively), the author tried the effects of passing solutions of tricalcic phosphate, alkaline carbonates and sulphates, ammonium salts, &c., through them, for the purpose of ascertaining the rate and extent of absorption. Inasmuch as the calcareous constituents in the natural soils would have interfered with the actions which it was now intended to observe, these matters were first removed by digesting in weak acetic acid and thoroughly washing with water. The soil thus purified was left for several days in contact with a carbonic aqueous solution of the tricalcic phosphate, a current of carbonic acid gas being occasionally passed, and after the lapse of a week the ferruginous soil was found to have withdrawn 93·8 per cent. of the phosphoric acid originally present in the solution, and only 49 per cent. of the lime. Hence the author believes that the ferric oxide and alumina may be considered to possess a special affinity for this mineral acid, and that all the phosphoric acid applied to land in the shape of manure must ultimately become converted into the phosphates of these bases. If the amount of iron be sufficiently large, all the phosphoric acid will be retained by preference in the form of ferric phosphate. The absorption power of soils for potassium salts was found to be much greater in the instances of the phosphate, sulphate, and carbonate, than with either the chloride or nitrate. The corresponding ammonium salts behaved in a similar manner. The author deduces from his experiments a general conclusion, to the effect that the absorptive action of soils, for the constituents named, i

dependent upon true chemical affinities, in contradistinction to the view which asserts it to be a consequence of the exercise of merely physical attractions.

Siliceous Stalactites.—In a letter to the editor of the *Chemical News*, Mr. Charles F. Burnand describes how siliceous stalactites are sometimes formed in the processes carried on in the preparation of "super-phosphates." He gives this explanation of the chemical change which produces these stalactites:—The sulphuric acid used in the process gives rise to the formation of fluoride of silicon, which, when it meets the moist steam, decomposes into hydrofluosilicic acid and silica, the latter being deposited in the form of stalactites.—Vide *Chemical News*, Nov. 8.

Political Chemists.—The editor of the *Moniteur Scientifique*, Dr. Quesneville, publishes a note in a recent number of his journal, in which he calls attention to the fact that French chemical science has recently been deprived of the services of two of its most distinguished devotees: MM. Millon and Naquet. The note is as follows:—"We have just heard two pieces of bad news. The first, which is irremediable, is the death of Millon, that distinguished chemist, whose career was cut short and health impaired by being sent to pass the best years of his life in Algeria, because his liberal opinions were too advanced to permit his remaining in Paris. The second is the arrest of our distinguished colleague M. A. Naquet, *Professeur Agrégé à la Faculté de Médicine*, which was doubtless owing to the same cause."

Volumetric Determination of Iron.—Herr Oudemans has recently pointed out a method by which the inaccuracies attached to the direct determination of iron, by means of hyposulphite of soda (Scherer's process), are avoided. To a solution of ferric oxide, which may contain much free chlorhydric acid, are added a few drops of a solution of a cupric salt, and potassic sulphocyanide sufficient to render the liquid dark red. A standard solution of sodic hyposulphite is then added until the red colour has entirely disappeared, which point may be observed with great accuracy. The action of the small quantity of cupric acid consists in causing a more rapid deoxidation of the ferric salt.—Vide *Zeitschrift für Analytische Chemie*, vi. 129.

The Derivatives of Itaconic Acid.—Those who are interested in this important subject should consult a splendid memoir which has been recently presented by M. Kekulé to the Royal Academy of Belgium. In it M. Kekulé criticises the researches of M. Swarts, on the derivatives and isomers of this acid. The memoir is too long and technical for abstract here; but those who are interested in the philosophic development of organic chemistry should consult it for themselves.—Vide *L'Institut*, Oct. 23.

A new Test for Hyposulphites.—In making some experiments on a delicate test for ruthenium, Mr. Carey Lea, the celebrated American chemist and philosopher, has found that ruthenium is itself one of the most delicate tests of the presence of the hyposulphites. Of course it must be admitted as a temporary objection to the new test that ruthenium is extremely rare; but then, on the other hand, we know that once a demand for a substance is created the supply soon follows. Mr. Lea gives the following account of the effects of ruthenium on the hyposulphites: "When a solution of ruthenium is rendered alkaline by ammonia and boiled with hyposulphite of soda, it gradually assumes a rose colour, which passes into a rich carmine;

with strong solution the colour is so intense as to be almost black. When diluted the shade is magnificent, rivalling the aniline red in richness. I have already stated within what limits ruthenium can be detected by hyposulphite of soda. I now subjoin the limits observed with respect to hyposulphite of soda. A solution containing one four-thousandth of hyposulphite, gave a clear rose red. One containing one twelve-thousandth gave a well marked pink liquid. One containing one twenty-five-thousandth gave a salmon colour. The experiment was not carried further because the salmon colour in the last-mentioned trial showed that the test had then reached its practical limit. I do not doubt that with even one hundred-thousandth a colouration could be obtained, but it would not have the specific distinctness given by the carmine and rose shade previously described."—Vide *American Journ. of Science*, September.

Conversion of Wood-Spirit into Aldehyd.—At the meeting of the French Academy on September 30, M. Dumas presented a memoir of Dr. Hofmann's, in which the author described how he obtained the transformation of wood-spirit into aldehyd—a problem which had failed in the hands of MM. Peligot and Dumas:—Dr. Hofmann placed in a sufficiently long tube a spiral of platinum, which he raised to the temperature of incandescence by means of a voltaic current; then he traversed the tube by a continuous jet of the vapour of wood-spirit; this vapour is sufficiently heated to be decomposed, and transformed into aldehyd, which can be collected in the form of a continued stream. The operation can be continued for several days, and it has been proved that more than two-thirds of the wood-spirit is converted into aldehyd.—Vide *Comptes Rendus*, Sept. 30.

Chemical Examination of Siliceous Minerals.—In a recently-published paper on the investigation of certain New Zealand minerals, Mr. W. Skey pointed out that the methods now in vogue among chemists are liable to numerous errors. After giving numerous details which we have not space to reproduce, he draws these conclusions:—First, that the present mode of extracting phosphoric acid from siliceous minerals for estimation is radically wrong, or at least very imperfect, much of the phosphoric acid these minerals may contain being determined to their silica when recently precipitated, if not already in combination therewith. Secondly, that in the great majority of the analyses of silicates, &c., the silica therein is given a trifle too high: and, lastly, that phosphoric acid exists in larger quantity and is even more widely distributed through the mineral kingdom than has hitherto been suspected—circumstances possessing some degree of interest in connection with both mineralogy and agriculture.—Vide *Chemical News*, Oct. 11.

Phosphoric Acid and Nascent Hydrogen.—In the *Zeitschrift Analyt. Chemie* [vi. 203] Herr Fresenius takes Mr. Herepath to task for his assertion that "phosphoric acid is reduced by zinc and sulphuric acid, so that hydric phosphide is mixed with the hydrogen evolved." Herr Fresenius has tried the experiment very carefully, but he has failed to find the result alleged by Herepath. 100 grammes of zinc were slowly dissolved in diluted sulphuric acid in presence of 10 grammes of sodic phosphate. The gases, after passing a small wash-bottle containing water, were conducted through two U tubes filled with a neutral solution of argentic nitrate. A small quantity of black precipitate was formed, which, on examination, was found to contain arsenic

and silver, but not a trace of phosphorus in any form. A similar experiment, in which no phosphate had been added to the zinc, gave the same result exactly.

Sesquichloride of Iron volatile.—It is asserted—though the assertion has recently been questioned—by Mr. W. Skey, of New Zealand, that sesquichloride of iron is volatile at the ordinary temperature of the air. Mr. Skey alleges that when this salt is rendered very acid by hydrochloric acid, the vapour from it gives a slight tinge of colour to a solution of sulphocyanide of potassium when allowed to impinge upon it.

Sulphocyanide of Ammonium in Gas-Mains.—In a paper read before the Literary and Philosophical Society of Manchester, Mr. Peter Hart gave several reasons for believing that sulphocyanide of ammonium exists in gas-mains. His first experiments were made to determine whether sulphide of iron—resulting from the action of the sulphide of hydrogen on the iron of the mains—was present. Removing a scale from the pipe, and placing a portion of it in pure hydrochloric acid, he perceived an intense reddening, much more than would be accounted for by the simple solution of peroxide of iron, and being aware of the fact of sulphocyanogen being one of the products of the distillation of coal, he at once suspected its presence. A portion of these scales was boiled in water. The clear liquid from this gave off much ammonia on the addition of alkali, and on the addition of a dilute solution of perchloride of iron it gave at once the intense colouration so characteristic of the sulphocyanides. The insoluble portion remaining on the filter was then boiled in dilute caustic soda; the filtrate from this made acid, and a solution of ferric oxide again added, this time with the production of a blue precipitate indicative of a ferrocyanide. This must have existed as ferrocyanide of iron, which on boiling with the alkali became oxide of iron and ferrocyanide of sodium. Mr. Hart thinks there is something curious in the fact of these bodies being carried such a distance (in this case fully a mile from the gas works) by the gaseous current. He regards the ferrocyanogen as the result of a reaction between the sulphocyanogen and the metallic iron or oxide of iron. The amount of these bodies must, he thinks, be far too small to have any bad effect on the health of gas consumers.—*Vide* report of meeting of *Manchester Literary and Philosophical Society*, Oct. 15.

GEOLOGY AND PALÆONTOLOGY.

The Belgian Bone-caves.—The explorations of these caverns, which have been carried out under the superintendence of M. Dupont, are still in progress. A report of some of the discoveries made in the course of the investigations has been laid before the Belgian Academy, and has been commented on by MM. d'Halloy and Van Beneden. The former considers that the results of all inquiries upon the remains in bone-caves go to prove the correctness of M. Dupont's opinion that man was a contemporary of the mammoth. The latter says that he does not agree with M. Dupont in thinking that the reindeer and horse lived in Belgium in the savage state.

He states that as all the other solipedes are either Asiatic or African, it is extremely unlikely that the horse originated in Europe.

Relation of Astronomy to Geology.—The study of geological phenomena in their relation to astronomical variations in the position of the earth has been very successful in the hands of Mr. James Croll, whose last paper "on the change in the obliquity of the ecliptic, and its influence on the climate of the polar regions and level of the sea," we have had the pleasure to receive. Mr. Croll's views are somewhat opposed to the current method of explaining geological phenomena, such as those of the glacial periods, but they are supported by a stern logic, and by a thorough acquaintance with both geology and astronomy, which cannot fail to give his opinions a powerful influence. So far as we can observe, his theory does not differ in many serious particulars from that propounded by Mr. Adhémar some years ago.

Volcanic Eruption in the Azores.—M. Fouqué, who was sent by the French Government to investigate this matter, has sent in his report. After considerable trouble he succeeded in collecting the gas, which is still bubbling up through the sea, in sufficient quantities for analysis. He states that it is quite free from carbonic acid and contains a very large proportion of oxygen.—Vide *Comptes Rendus*, Oct. 21.

The Geology of Wells.—We are glad to see that in the last report of the medical officer of the Privy Council the important question of the geological character of wells has not been overlooked. The relation of geology to hygiène is one of considerable moment, and it is satisfactory to find that the State Sanitary Department has taken the initiative in pointing out this relationship to those engaged in inquiries upon questions of public health. Out of a list of 90 wells, of ascertained depth, 5 were between 40 and 50 feet; 21 were between 30 and 40 feet; 24 were between 20 and 30 feet, whilst 40 were only from 9 to 20 feet in depth. When, notwithstanding all the efforts to the contrary, the sewage of a population like London is daily affecting the subsoil to a greater or less extent, it stands to reason that all superficial sources of water-supply within the town-area must be seriously vitiated by ancient cesspools and other unremoved nuisances which yet haunt many of the poorer suburban quarters of our great city. In addition to the Tabulated List of Wells in London, there are 15 tables, comprising upwards of 206 ascertained borings along the various lines of the Metropolitan Main Drainage Works.

The Granites of Leinster and Donegal.—In the course of the controversy, not yet concluded, concerning the origin of granite, Mr. W. H. S. Westropp has drawn the attention of geologists to a question of some seriousness. He asks, Are we to suppose that notwithstanding the vast difference between their modes of occurrence in the field, the granites of Leinster and the granitoid rocks of Donegal must have had a like origin, merely because they have a *somewhat* similar mineral composition, both containing quartz, feldspar, and mica? But have these rocks an identical mineral composition? So far as his experience goes, most assuredly not. They vary in appearance, texture, mode of aggregation of the component minerals; the quartz has a different look, difficult to describe, but, once seen and observed, not easily to be forgotten. But above all, they differ widely in their feldspathic constituents,

for while the intrusive granites are orthoclasic, or, as in Down, sometimes albitic (and, let it be remembered, albite is as highly silicated as orthoclase), and the uncrystallised feldspathic paste is always highly silicated, the granitoid rocks on the other hand contain, notwithstanding the presence of free quartz, a large proportion of basic feldspars, of which oligoclase is the most recognisable, and the feldspathic paste is basic also, approaching oligoclase or anorthosite in composition.—Vide *Geological Magazine*, Nov.

A new Terminology.—In a paper on brecciated formations, in the *Geological Magazine* for November, Mr. John Ruskin defines the several terms which he considers it necessary to employ in describing these structures. We do not know what physical geologists will think of Mr. Ruskin's employment in a new sense of very old and well-understood expressions, but for the benefit of those of our readers who may be interested in this particular branch, we transcribe Mr. Ruskin's definitions. "1. Supposing cavities in rocks are produced by any accident, or by original structure (as hollows left by gas in lava), and afterwards filled by the slow introduction of a substance which forms an element of the rock in which the cavities are formed, and is finally present, in the cavities, in proportion to its greater or less abundance in the rock; I call the process 'secretion.' 2. But if the cavities are filled with a substance not present (or not in sufficient quantity present) in the surrounding rock, and therefore necessarily brought into them from a distance, I call the process, if slow, 'infiltration;' if violent, 'injection.' It is evident that water percolating a rock may carry a substance, present in the mass of it, by infiltration, into the cavities, and so imitate the process of secretion. But there are structural differences in the aspect of the two conditions hereafter to be noticed. The existence of permanent moisture is however to be admitted among conditions of secretion; but not of fluent moisture, introducing foreign elements. 3. If a crystalline or agatescent mass is formed by addition of successive coats, I call the process 'accretion.' 4. But if the crystalline or agatescent mass separates itself out of another solid mass, as an imbedded crystal, or nodule, and then, within its substance, divides itself into coats, I call the process 'concretion.' The orbicular granite of Elba is the simplest instance I can refer to of such manifest action; but all crystals, scattered equally through a solid enclosing paste, I shall call 'concrete' crystals, as opposed to those which are constructed in freedom out of a liquid or vapour in cavities of rocks, and which I shall call 'accrete.'"

An Eocene Shore-Crab.—A species of shore-crab, recently discovered in the Eocene beds of Hampshire, has been described by Mr. Henry Woodward under the title of *Goniocypoda Edwardsii*, the specific name being given in compliment to M. Alphonse Milne Edwards, to whom crustaceous palæontology is so much indebted. The specimen may be seen at the British Museum. It is about eight lines long, and is embedded in a piece of sandstone, the dorsal portion being alone exposed. Like all shore-crabs, the carapace is much swollen, especially in the branchial region.—Vide *Geological Magazine*, Dec.

The Amiens Gravel.—In a valuable paper, read before the *Geological Society*, at its meeting November 7, by Mr. A. Tyler, the following conclusions were based upon the evidence adduced by the author:

(1) That the surface of the chalk in the valley of the Somme had assumed its present form prior to the deposition of any of the gravel or loess now to be seen there; (2) that the whole of the Amiens valley gravel is of one formation, of similar mineral character, contains nearly similar organic remains, and belongs to a date not much antecedent to the historical period; (3) that the gravel in the valley of the Somme at Amiens is partly composed of débris brought down by the river Somme and by the two rivers the Celle and Arve; and partly of material from the higher grounds washed in by land-floods; (4) that the Quaternary gravels of the Somme are not separated into two divisions by an escarpment of Chalk parallel to the river, as has been stated; (5) that the evidence of river floods extending to a height of at least 80 feet above the present level of the Somme is perfectly proved by the gradual slope and continuity of the gravels deposited by them; and (6) that many of the Quaternary deposits in all countries, clearly posterior to the formation of the valleys in which they lie, are of such great dimensions and elevation that they indicate a Pluvial period just as clearly as the Northern Drift indicates a Glacial period.

Eocene Shells.—It is reported that M. Deshayes' splendid collection of Eocene shells, from the Paris Basin, has been purchased by the French Government for the Museum of the *Jardin des Plantes*, at a cost of 100,000 florins.

The Silurian System of Bohemia.—M. Barrande has issued four new volumes of his splendid treatise on this subject. They embrace descriptions of all the fossils included in the orders Pteropoda and Cephalopoda.

A Perfect System of Palæontology is arrived at by M. Paul Gervais, who is now publishing a comprehensive work on "General Zoology and Palæontology." The first four parts of his treatise have been presented to the French Academy. They deal with the subject of the Antiquity of Man and the Animals of the Quaternary period.

Middle and Upper Lias of the South-West.—We have received from Mr. Chárles Moore, F.G.S., a reprint of his valuable memoir on this subject, which appeared in the Proceedings of the Somersetshire Natural History Society. It extends over more than 100 8vo. pages, and is illustrated by several admirably drawn plates. It deals minutely with the characters and distribution of the Liassic deposits of the South-west of England, and describes the organic remains which they contain. Essays like this are extremely creditable to our provincial societies, and they show that advanced research is not confined to metropolitan workers.

The Eruption of Vesuvius.—A letter has been received at Paris by M. St. Claire Deville, from Signor Palmieri, in which the latter gives an account of the last and still existing eruption of Mount Vesuvius. The eruption commenced on the 12th of November. About the end of October it was found that the temperature of the older craters was getting higher than usual, and that large quantities of vapour were from time to time evolved. Early in November the disengagements became continuous and the *sismograph* gave indications of a series of slight shocks. Then, at the date mentioned, the discharge of incandescent matter commenced; and the enormous masses of compact lava which had before filled the crater were lifted out, thus opening up four new and small craters, which afterwards became larger,

and the discharge of lava then became regular. Disturbance of the magnetic needle and repeated registrations by the sismograph were then observed. At the date of closing the letter (Nov. 17th) the stream of lava was winding round the side of the great cone, and in the direction of the crater of 1855.

The Anatomy of the Mesotherium.—In one of his series of Memoirs, published in the *Comptes Rendus,* M. Serres thus sums up his opinions of the affinities of the Mesotherium:—It approaches the Rodentia, by the disposition of its incisor teeth; in its general form it resembles the young Pachyderms. It is related to the Edentata, by the form of its head and limbs, and by the bifurcation of the last phalanx. Finally, its conformation of head and form of encephalon relate it to the Cetacea, to which group M. Sénéchal supposes it to belong. Looking at all the anatomical characters, M. Serres thinks the Mesotherium should be placed between the Pachyderms and the Rodentia; and he thus looks upon it as an extinct connecting link in the mammalian chain. In another of these papers he alleges that the animal was aquatic in its mode of life, and he bases this conclusion on the following evidence:—1. The direction of the superior articulation of the humerus, which, he says, shows that the limb had a horizontal position. 2. The arrangement of the fore-arm, which was very wide and moveable, resembling that of the seal family. 3. The separation of the digits. 4. The character of the thumb, which is long, slender, and evidently possessed the power of abduction, a membrane extending between it and the index-finger. 5. The end-to-end articulation of the bones of the fore-arm, phalanges, carpus, and metacarpus.

The Igneous Origin of Eruptive Rocks.—In an excellent critique on Dr. Sterry Hunt's lecture on the Origin of Rocks, Mr. David Forbes, F.R.S., thus expresses himself in regard to the origin of eruptive rocks:—"It has lately been the fashion, especially amongst many of the younger votaries of the science, to 'pooh-pooh' the igneous origin of eruptive rocks in general, and of granite in particular. A careful study of the literature of the subject shows, however, that this secession from opinions, previously all but universally adopted, has originated in the writings of one or two able but one-sided men of science, blindly followed, as is usual in such cases, by adherents who reason not for themselves, or who have either not sufficient leisure or inclination to examine into the true merits of the question. The author fully believes, however, that had anything like a careful study of what has already been published (*pro et contra*) upon this subject been made, that not only would an explanation or answer have been discovered to meet any and all of the arguments brought forward in opposition to the igneous origin of such rocks, but that such as are open to conviction would, with the author of these remarks, have come to the conclusion that nothing has as yet been advanced which can in any way tend to prove the eruptive rocks to have an origin differing from that of those rocks produced by volcanic action at the present day."—Vide *Geol. Mag.*, October.

Photographs of Santorin.—Herr Haidinger lately presented to the Viennese Academy a number of photographs of the different stages of the Santorin eruption. They had been "taken" by M. Granges.

The Geology and Palæontology of Russia.—M. D'Eichwald's treatise, bearing this title, has been published.

Fossil Fishes of Carinthia.—Herr Kner has issued a supplementary list of the fossil fishes of Carinthia. In this he describes a species (*Pterycopterus æpus*), which is provided with wing-shaped pectoral fins, and which forms the type of a new genus allied to *Thorecopterus.*

The Flint Implements of Treiche.—In a description of the ancient flint implements found at Treiche, near Toul, M. Guerin states the following opinions :—1. The Plateau of Treiche, on a surface of at least fifty acres, was the seat of a sort of manufactory of flint implements of the same antiquity as those of Grand-Pressigny. 2. These weapons are older, judging by their form and finish, than those of the Caves of Sainte-Reine. 3. The flints found here are of the diluvian class, and are very small.

MECHANICAL SCIENCE.

British Association.—Amongst the papers read before the Mechanical section of the British Association we may record as of permanent importance that by Mr. John Platt, of Oldham, on cotton machinery ; the collection of tables of steamship performance and report thereon, by a committee of the Association ; the Rev. Mr. Bell's narrative of the invention of the reaping machine ; and Mr. Bateman's account of the Manchester waterworks.

Strength of Steel.—Dr. W. Fairbairn, F.R.S., has published a very valuable series of researches on the tensile, transverse and compressive strength of steel of various qualities. The mean value of the modulus of elasticity obtained was 31,000,000 lbs. ; the minimum 22,098,000 lbs. ; the maximum 32,672,000 lbs. The value of the modulus of resistance to transverse strain at the elastic limit (or resistance of bar 1 inch long and 1 inch square) varied from 3·108 to 7·856 tons. The tenacity varied from 26·57 to 59·87 tons per square inch. From the experiments on transverse strain Dr. Fairbairn concludes that the cost of railway bars and similar structures of iron and steel is in the ratio of 1⅓ to 1 for equal strengths, irrespective of the greater durability of steel, and taking the price of steel at 12*l.* and of iron at 7*l.* per ton. The importance of this deduction cannot be over-estimated at a time when the great durability of steel rails is exciting so much attention.

Slide Valves.—Mr. J. R. Napier and Professor Rankine propose to remove the objection to the slide valve and link motion as a means of obtaining a variable rate of expansion, by making the seat of the valve moveable. The convenience of the link-motion with a single valve is well known, but when used to cut off the steam at variable points in the stroke an objection arises from the fact that the points of admission, cut off, release, and compression are so related, that fixing any three of these positions fixes the fourth also ; and it often happens that the best positions of release and of compression are inconsistent with each other, so that a compromise has to be made. This objection is proposed to be obviated by giving a small sliding motion to that part of the valve seat which contains the induction edges of the cylinder ports, so as alternately to contract and enlarge those ports at each stroke of the engine. The valve seat is moved by a rod and third eccentric. It need

scarcely be said that the improvement is thoroughly sound in principle, and promises to be of much practical use.

Experiments on Rigidity.—The rigidities of glass, brass, and steel have been very carefully determined by Dr. J. D. Everett, on a method suggested by Sir William Thomson.

Steel, Strength of.—Mr. T. E. Vickers, of Sheffield, has made some interesting experiments on the strength of steel, the proportion of carbon being approximately determined at the same time. With 0·33 per cent. of carbon the tenacity was 30·4 tons per square inch, and the strength increased steadily as the amount of carbon became greater, until with 1·25 per cent. of carbon the tenacity reached 69 tons. Simultaneously the elongation of the bars diminished from 1·37 metres to 0·62 inches, and the specific gravity from 7·871 to 7·823. The toughness, as indicated by capacity for resisting blows, was greater in the steels which contained least carbon.

Concrete Buildings.—Some experiments are being made in Paris and at Gravesend in building houses with concrete walls, and an interesting paper on the subject will be found in a recent number of the *Fortnightly Review*, by Henry Conybeare, Esq., C.E., in which the opinion is expressed that concrete walls, faced with glazed tiles, will form the most important element in the future of London architecture.

Resistance to Projectiles.—Experiments by the Rev. F. Bashforth, under the direction of the Ordnance Select Committee, give for the resistance of the air to the motion of projectiles,

$$\rho = \beta v^3$$

or the resistance proportional to the cube of the velocity.

Testing Iron by Magnetism.—A method of ascertaining the existence of flaws in wrought-iron bars by the magnetic needle has been discovered by Mr. Saxby, and has for some time been under experiment at Chatham. The results of some of these experiments are described by Mr. Paget in the *Engineer*. If a bar of homogeneous soft iron be placed in the magnetic equatorial plane, that is, nearly east and west, it will become temporarily magnetic, one side of the bar assuming a north, and the other a south polarity. If, now, a small magnetic needle be passed in front of this bar, it will not be disturbed from its true position at right angles to the bar. If, however, the bar be not homogeneous, but composed of iron of different degrees of hardness, or containing flaws and solutions of continuity, the magnetic condition of the bar will no longer be uniform, and in passing in front of it, the small magnetic needle will deviate from its true position. In the recent experiments at Chatham, Mr. Saxby examined in this way a number of bars, and marked on them the points at which any deviation of the needle was observed. These bars were afterwards broken in the testing machine, and in every instance broke at the points marked by Mr. Saxby. A bar of three descriptions of iron, welded up and painted over, was shown to Mr. Saxby, who immediately detected the inequality of texture. A small pin of steel was inserted longitudinally into a 4-inch wrought-iron bar and welded up; its position was accurately detected by the needle. No method has yet been found for testing plates.

Endurance of Heavy Guns.—Mr. Arthur Rigg, C.E., has endeavoured to

prove, in a paper read before the Society of Engineers, that the endurance of ordnance is closely dependent on the ratio of the mass of the breech to the mass of the barrel. The greater the mass of the breech the greater the endurance of the gun. The following table gives some of the facts on which Mr. Rigg founds his theory:—

Gun	Ratio of Mass of Metal in Breech to Mass of Metal in Barrel	No. of Rounds before bursting	
English cast-iron 68-pr	1 to 4½	2,000 to 4,000	
Whitworth 70-pr	1 „ 17	111	Coils slipped.
Armstrong 300-pr	1 „ 7	264	Breech blown off.
American Dahlgren 30-pr	1 „ 2½	2,000	Not burst.
„ Parrott 200-pr	1 „ 9	230	
„ Parrott 30-pr	1 „ 2¼	4,606	

These facts, which are the most important of those quoted by Mr. Rigg, culled from his paper and arranged for comparison, would seem to bear the interpretation of the relative weakness of heavy guns as well as that which Mr. Rigg founds on them. But there is probably some truth in Mr. Rigg's theory, that a heavy breech absorbs the blow of the explosion and lessens the longitudinal strain. It certainly appears that improved modes of constructing guns, whilst adding greatly to the power of the barrel to resist bursting, have in some cases dangerously diminished the longitudinal strength.

Road Locomotives.—Mr. R. W. Thomson, of Glasgow, is using india-rubber tires 12 inches wide and 5 inches thick, for road locomotives, with great success. With these tires the engine passes easily over the softest and roughest ground; and, strange to say, the tire shows no signs of wear.

A Simple Fire-Escape.—We so often hear of, in cases of fire in dwellings, the inmates throwing themselves as a *dernier ressort* out of windows, and their sustaining serious injury, that the suggestion of one of our correspondents seems worthy of notice. H. B. writes: "Would you allow me to suggest whether a belt attached to a strong rope wound round as measuring-tapes are on a reel, the said reel having an iron ring attached (something in the plan of those on which keys are put) so as to admit of the ring being fastened round a bedpost, or leg of a chest of drawers, &c., might not afford in time of extreme necessity a chance of escape—the rope to which a person was attached by the belt running out as the jump from a window was made, and able to be pulled up by any other unfortunate when it was detached? Of course the experiment would be a last resort, but might it not afford a possibility of escape at very trifling expense?"

MEDICAL SCIENCE.

The Functions of the Pancreas.—At the meeting of the Royal Society, on the 12th of December, a paper by Dr. Dobell was read, in which the author described the results of his experiments with the extract of the pancreas upon fat. He proposes to give the term *pancreatine* to all those extracts of the gland which possess the power of emulsifying fatty matter. He found that the secretion was frequently acid. At the conclusion of the

paper, Dr. Pavy stated, what we think will be admitted by all physiologists, that in these observations Dr. Dobell has been anticipated by the researches of Claude Bernard, published many years since, and described in most treatises on physiology. We may add, that the function of the pancreas is a much higher one than even Bernard thought it to be. The researches recently made by Herr Kühne, and published in a paper read before the Royal Academy of Berlin, are evidence of this. They prove that the pancreas not only emulsifies fatty matter, but that it is capable of promoting the digestion of albuminous matters. The pancreatic juice acts as a ferment, converting (when the process is continued for any length of time) albumen into peptone, and this again into leucine and tyrosine.

The Exaction of Nitrogen.—The Vienna Academy has received from Herr Seegen a very important communication concerning the question of the exaction of nitrogen in the animal body. The following are the results arrived at:—1. Besides the alimentary canal and kidneys, there are other channels through which the nitrogen contained in the transposed nitrogenous tissues may be expelled. 2. Under certain undefined conditions the whole of the transposed nitrogen is contained in the solid and liquid excrementitious matters. 3. Under other circumstances a portion of the nitrogen is excreted through other channels (probably the skin and lungs). 4. It is therefore incorrect to regard the difference between the nitrogen ingested and that excreted by the solid and liquid excrements as an addition to the tissues of an animal.

Amaurosis from Tobacco-smoking.—Mr. Hutchinson has reported thirty-seven cases of amaurosis, of which he says thirty-one were among tobacco-smokers.—Mr. Hutchinson concludes:—1. Amongst men, this peculiar form of amaurosis (primary white atrophy of the optic nerve) is rarely met, except among smokers. 2. Most of its subjects have been heavy smokers—half an ounce to an ounce a day. 3. It is not associated with any other affection of the nervous system. 4. Amongst the measures of treatment, the prohibition of tobacco ranks first in importance. 5. The circumstantial evidence tending to connect the affection with the habit of tobacco-smoking is sufficient to warrant further inquiry into the matter on the part of the profession.

A Deaf and Dumb Bachelor of Science.—According to a statement in the *Journal of the Society of Arts* for Nov. 22, a pupil of the Deaf and Dumb Asylum of Paris has received the degree of Bachelor of Science. This is the first bachelorship of the kind on record.

The Unstriped Muscles of the Eye form the subject of a paper by M. Sappey in the *Comptes Rendus* for October. The author has dealt somewhat fully with the muscle of the eyelid, and he proposes to describe also the ciliary muscle.

Effect of Electricity on the White Blood Corpuscles.—This subject has lately received some attention from Professor Neumann, of Königsberg, who has pointed out some remarkable facts. He finds that under the influence of strong induced currents the white corpuscles of the frog swell out, their walls become quite smooth, and a clear space is left between the wall and the granular nucleus in the interior. The molecules in the cell commence, too, to exhibit rapid movements.

Microscopic Examination of Secretions.—The value of the microscope as a substitute for the test-tube in the qualitative analysis of secretions, such as urine, has been very well illustrated in a paper read at the late Pharmaceutical Congress, by Mr. Stoddart. This gentleman endeavoured to show that a mere chemical examination of a substance was of little value, since it gave no indication of how the several constituent elements were combined. He gave an illustration of the value of the microscope to the chemist, by showing that in the examination of animal secretions no less than seven different substances could be detected in a few minutes, by applying the tests to a drop of the secretion placed under the microscope, and watching and noting the form of the crystals then formed.

A Galvanic Probe-indicator, which would be found useful in searching for bullets in gun-shot wounds, has been lately described by an American surgeon. It consists of a pair of forceps whose limbs are electrically isolated, and are in connection with the wires of a battery. It is employed in gunshot wounds in searching for the ball. If it touches a ball the isolation is broken, and a current being formed, a small bell in connection with the battery is caused to ring. The idea is an admirable one theoretically; it only remains to be seen whether the tissues themselves, in the absence of a ball, may not be sufficient to complete the current, and thus give an indication of the presence of a ball where no ball existed. It was first described in England in the *London Review* of Nov. 30, and it elicited a letter from Mr. De Wilde the engineer, who claims the merit of originating this instrument some years ago.—Vide *London Review*, Oct. 7.

Physiological Action of Calabar-bean.—We have received from Dr. Fraser, of Edinburgh, a copy of this fine memoir upon the action of the ordeal-bean. This essay, which is reprinted from *The Transactions of the Royal Society of Edinburgh*, is thoroughly exhaustive in its treatment of the subject, and is, we should say, the most elaborate monograph upon a single poison yet published. Dr. Fraser records the results of a multitude of experiments made to determine the action of this substance on the various organs of the body, but that part which relates to the influence of physostigmine on the iris is especially important. With regard to the relative effects of atropine and physostigmine, Dr. Fraser says that the changes in the iris appear to require the co-operation of special radiating and circular muscular fibres, with a system of contractile blood-vessels possessing to a certain extent the properties of erectile tissue. A mere antagonism between the two muscular apparatus could not, he thinks, alone account for the effects of either atropine or physostigmine. All the muscular fibres in the iris are unstriped, and physostigmine relaxes, while atropia contracts such fibres.

Experiments on the Cause of Scurvy.—M. Prussak, of St. Petersburgh, has published an account of some experiments, which go far to demonstrate the relation between scurvy and the presence in the blood of an excess of common salt. M. Prussak placed the web of a frog's foot under the microscope, so as to observe the passage of the blood through the smallest blood-vessels. He then injected a solution of salt beneath the frog's skin, and watched the effect on the vessels. He perceived that the blood corpuscles distended the vessels, and gave rise to the patches of dark-coloured extravasations, extremely like the peculiar livid blotches seen on the skin of

scorbutic patients. Experiments on dogs and other animals appeared to give the same results. Of course these facts require confirmation before they are accepted as the basis of an explanation of scurvy, but in the meantime they tend to show the nature of the injurious effects produced by an excess of sodic chloride as an article of diet. It remains, too, to be shown on what physical law the production of the ecchymoses depend.—Vide *L'Institut*, October.

Effect of Boric Acid on Albuminous Matters.—Continuing his inquiries upon the action of boric acid on flesh and albumen, Herr Brücke has discovered one or two important points. He finds that the boric differs from all other mineral acids, save carbonic in its action on albumen. A solution of boric acid containing only 2 per cent. does not coagulate blood or milk, and does not produce syntonine by its action on albumen. On the contrary, borate of soda, like carbonate, transforms ordinary albumen into precipitable albumen.

Researches on Santonine.—Santonine, when given internally, soon affects vision in such a manner as to give everything seen by the eye a yellow tinge. That it has, however, further properties would seem from the inquiries of M. Pelican, of St. Petersburgh, who concludes:—1. That santonine produces a sort of paralysis, accompanied by rigidity of the muscles. 2. In the way in which it produces these effects it shows an analogy to atropine and physostigmine. 3. It entirely destroys the irritability of muscles, rendering them completely rigid. 4. It is a substance whose therapeutical action should be more thoroughly investigated.

Preparation of Sections of the Brain.—There is no more difficult substance to examine satisfactorily with the microscope than the brain, and as the methods hitherto employed in preparing sections have been both troublesome and tedious, we are glad to be able to lay before our readers a mode recently suggested by Dr. Bastian, Professor of Pathology in University College, which we think is at once simple and expeditious:—The tinted section is placed for four or five minutes in a watch-glass with pure spirits of wine, then removed on a scalpel—the superfluous spirit being got rid of by bringing the dependent edge of the section in contact with blotting-paper, and afterwards placed on a drop of carbolic acid in the centre of a glass-slip. In less than two minutes the section is rendered transparent; and when this is accomplished (having got rid of any excess of carbolic acid), three or four drops of chloroform are poured over it, in which the specimen is allowed to remain for two minutes. The superfluous chloroform is then poured off, whilst one or two drops of a solution of Canada balsam in chloroform are dropped over the specimen, and the covering-glass is then quickly applied. The whole process is therefore simple, and extends over ten minutes, even for moderately thick sections, instead of hours.—Vide *Journal of Anatomy*, November.

Organisms in Respired Air.—The researches of M. Lemaire are being continued on this point, and a paper lately published reports their results. M. Lemaire states that not only in the air which passes from the lungs, but also in the perspiratory fluid, he finds abundant indications of animal and vegetable life. The organisms discovered by him include various species of Bacterium, Vibrio, and fungoid plants. Besides these he has noticed peculiar spherical or ovoid diaphanous bodies, which he is unable to assign to any particular group.—Vide *Comptes Rendus*, Oct. 14.

The Chemistry of Respiration.—Herren Pettenkofer and Voit, who have added so largely to our knowledge of the physiology of respiration, have lately undertaken a series of researches in their large respiration apparatus at Munich, with a view to determining to what extent the respiratory functions vary during the day and during the night. Their first experiments were conducted upon a young watchmaker, aged 28 years, and led to a remarkable result, in respect to the difference in the amount of oxygen absorbed and carbonic acid evolved during the day and night periods. The experiments included one day of rest, during which the man amused himself by reading and repairing a small clock, and a day of labour in which he was made to turn a wheel heavily charged. The chief conclusions which may be drawn from these experiments are the following: 1st, That in 24 hours the volume of the CO_2 eliminated is about equal to that of the O absorbed; 2nd, That the interchanges of gas effected by respiration go on differently by day and by night, so that the greater part of the O absorption takes place by night and the greater part of the CO_2 elimination by day. Work has scarcely any immediate influence on the oxygen absorbed during the day, although it has a great immediate influence in the amount of CO_2 eliminated. This seems to be formed at the expense of oxygen which has been stored up. 3rd, The excretion of urea is not increased by work, although this be long sustained. 4th, The elimination of water is very much increased by work, and the increase continues during the ensuing hours of sleep. Pettenkofer and Voit have, we believe, since repeated these experiments on the man who was the subject of the above experiments, but without confirming the results as to the difference between the day and night periods.—Vide *Annalen der Chemie*, CXLI. Heft 3, and *Journal of Anatomy and Physiology* for November.

Wounds treated by a Vacuum.—MM. Guerin and Maisonneuve have almost simultaneously brought forward proposals similar in principle, though differing somewhat in detail, for the treatment of wounds by removal of the air. The more perfect mode is that described by M. Guerin, which is applicable to a large number of wounds, and which by a series of tubes may be placed in communication with several patients at once. The advantage claimed for the process is that it causes the wound to cicatrize more quickly than by the ordinary method. A sort of air-tight cap is placed over the wound, and this is placed in communication with a chamber to which is attached an air-pump and a tube of mercury. The amount of the vacuum is ascertained by the height of the mercury in the tube (*manometer*). The effects of this process are the prevention of the action of the air on the wound, and the gradual but constant removal of the unhealthy fluids formed in the healing tissues.

Therapeutical Effects of Hydrocyanic Acid.—Contrary to the usual doctrine, it is alleged by M. Poznanski, in a note to the French Academy, that cyanhydric acid is rather a stimulant than a sedative, and that as such it is a valuable remedy in cases of cholera. He gives it in doses of 12 drops every 24 hours.—Vide *Comptes Rendus*, Oct. 7.

The Pathology of Chlorosis.—In a paper read before the Academy of Sciences of Vienna, M. Duncan, of St. Petersburgh, stated that the pallor of chlorotic patients does not arise from diminution of the number of the red

corpuscles, but from a decrease in the proportion of colouring matter which these globules shall contain.—Vide *L'Institut*, Oct. 9.

Tinting Microscopic Structures.—Herr E. Schwartz has addressed a note to the Viennese Academy, in which he states that he has discovered a mode of obtaining simultaneously two layers of a tissue (such as the stomach) with different colouring matter. He did not describe the process, but he sent coloured drawings showing the effects produced. He alleged that by means of the new process he has been able to discover structures which have hitherto been obscured or lost sight of.

METALLURGY, MINERALOGY, AND MINING.

Advantages and Disadvantages of Nitro-glycerine.—In a late number of the *Berg-und-Hüttanmannische Zeitung*, Herr Richter has contributed a paper of some length and of considerable interest, upon the advantages and disadvantages of nitro-glycerine as a blasting material, a subject of much interest since the fatal explosion at Newcastle The conclusion which he has arrived at may be thus summed up:—1. Fewer men are wanted for working out a certain sized piece of ground, and fewer holes have to be bored than at present. A dearth of miners may to a certain extent be remedied in this manner, and less steel and iron will be used than hitherto. 2. Nitro-glycerine does not take fire easily, and when lighted burns but does not explode, and goes out as soon as the flame with which it had been brought in contact is taken away. 3. The holes can be tamped easily, quickly, and without danger. 4. The amount of smoke after a blast is small compared with that of powder, and workmen can go back at once to the place where they have blasted without trouble. This is a considerable advantage in places where there is but little draught, and holes can be bored and fired singly, which was hitherto almost impossible in consequence of the all but impenetrable smoke, and had to be avoided as much as possible. 5. Holes that have missed or only partly torn can be retamped and shot off, which, with the present arrangements is either impossible or accompanied by great danger. Against these advantages must be set the following disadvantages:—*a.* The gases formed during the explosion of the nitro-glycerine have an injurious effect on the organs of sight and respiration. *b.* Nitro-glycerine explodes on being struck smartly, and easily freezes. *c.* The masses of rock which it removes are mostly very large, and considerable time has to be spent in breaking them up.

Solder for Steel.—The best solder for steel for fine work is, says the *American Artizan*, a compound of nineteen parts of silver, one part of copper, and one part of brass. Borax is also said to be the most efficient flux.

Rock Crystal.—Rock crystal, of very fine quality, has been discovered in Arkansas. Rock crystal is described as the purest vitreous variety of quartz, and includes pure regularly-formed crystals of quartz, their most usual form being that of hexagonal prisms, surmounted by pyramids. In the United States it was first discovered in Herkimer county, New York, and afterwards in London county, Virginia, and in the State of Vermont and other localities. Vide *The Artizan*, Nov.

Generation of Steam and Prevention of Smoke.—Experiments in relation to these two points have been conducted during the past eighteen months, under the direction of the late Dr. Richardson, of Newcastle, and Mr. L. E. Fletcher, chief engineer to the Association for preventing Steam Boiler Explosions. These experiments are conducted on a large scale, and the expenses have been borne by the South Lancashire and Cheshire Coal Association. Although the experiments are not yet completed, being still in daily progress, they demonstrate that the formation of smoke may be entirely prevented, without any diminution of the evaporative efficiency of the coal, *by careful firing* alone, whilst economy is promoted at same time.

Ruballite, or Red Tourmaline.—In the *Proceedings of the Royal Society of Victoria* is a paper by the Rev. Dr. Bleasdale on this Victorian mineral. At the meeting at which the paper was read, Dr. Bleasdale exhibited specimens of the mineral, all of which were embedded in quartz crystals. As a gem, when the colour is perfect, it is said to possess great beauty. It has been only recently discovered.

South African Mineralogy.—We learn from one of the Cape papers that the discovery of precious stones is exciting a good deal of attention in South Africa, owing to a little girl having recently picked up what she considered to be a pretty stone, which turned out to be a diamond worth 500*l.* Garnets have also been recently found in considerable numbers. It is also reported that silver, mercury, amber, and oil-stones have been found in some quantity.

A Deposit of Rock-salt.—The Prussian Government has been recently making active researches in the kingdom to discover fresh mines of rock-salt. The borings, executed under the orders of Count d'Itzenplitz, Minister of Commerce, have now led to the discovery of a rich deposit of that mineral near Sperenberg, to the north of the Lake Krummsee, at a distance of twenty-two miles from Berlin. The salt is found at a depth of 300 feet from the surface.—Vide *Journal of Society of Arts.*

Soluble Mineral in Preserving Stone.—One of our contemporaries expresses itself in high terms of praise of a process for the preservation of stone, which has been discovered by Messrs. Dent and Brown, of the Chemical Department, Woolwich. "Their process consists in the application of a solution of oxalate of alumina to the stone. The experiments date from December, 1865, and the results they have now obtained are most encouraging. The process is applicable to limestone, dolomite, and chalk, and may, we think, be made subservient to the preparation of lithographic stones. Oxalate of alumina is readily soluble in water, and the solution, which is simply applied with a brush, is made of a strength varying with the porosity of the material to which it is to be applied. The specimens we have before us are left in the original condition at one end, and have been prepared with the solution at the other. The physical characteristics of chalk so treated are—lightness, the possession of a glazed surface approaching somewhat in appearance marble, and greatly increases hardness; in this respect the stone is about equal to Fluor spar, or 4 in Mohs' scale. Furthermore, the lime being transformed into one of the most insoluble and unalterable of its compounds, and the alumina being precipitated, the pores are filled with a substance almost unacted upon by water or by the impurities present in the atmosphere of large cities."—Vide *Chemical News*, Oct. 25.

Trinidad Asphaltum.—It seems that three varieties of this natural product were shown at the Paris Exhibition. These are derived from the Pitch Lake of Brea in Trinidad, which, says the *Society of Arts Journal*, covers 100 acres and yields enormous quantities of asphalte, whose value has not yet been recognised in Europe. Lacquer pitch, found in the vicinity of the Pitch Lake, is recommended as an ingredient entering into the composition of dark-coloured varnishes. Its commercial value is great, but the supply is by no means ample. Larger quantities may possibly be obtained by deep sinking. The export of asphalte from Trinidad in 1865 was 17,700 tons, principally to Belgium, France, and England. One company in the island has entered into a contract to supply 1,500 tons yearly of asphalte, in blocks fit for paving, at nine dollars the ton, delivered on board. The same company has engaged to furnish a house at Antwerp with 20,000 tons at 50*s.* per ton, to extract oil from.

MICROSCOPY.

A "live-box" for Tadpoles, which is both ingenious in conception and easily constructed, has been devised by Herr F. E. Schultze, and is described and figured in the *Microscopical Journal* for October. The object of such a contrivance is to enable the student to examine the circulation, &c., of the tadpole without placing the animal under artificial conditions. Heretofore workers have employed a thick glass slide, into which a depression was ground, in which the object was placed. But as the grinding out of a hollow of this kind in a thick piece of glass would be attended with difficulty, and consequently with considerable expense, Herr Schultze has always constructed the apparatus of three flat pieces of glass. The lower of these is nothing more than a common slide, and upon this, as a basis, the two others, in which the requisite incisions have been made, are affixed by means of Canada balsam (or marine glue). When used the hollow is filled with water, into which the animal is introduced, with its head beneath the anterior border, and the tail in the shallow depression at the other end, or on the surface of the glass, as the case may be, the whole being covered with thin glass in the usual way.

A Novel Animalcule Cage has been invented by Mr. W. Moginie, in the establishment of Messrs. Baker, of Holborn. It is certainly a vast improvement upon the old live-box, and it is cheap and efficient. In constructing it Mr. Moginie grinds down to a fine surface a little brass hinge, enlarges its two screw-holes to about ⅜ of an inch, and then fastens one of its sides to an ordinary glass slide by means of marine glue. He next cements a piece of thin "covering glass" over the upper aperture in the hinge. The cage is thus ready for use. A drop of fluid containing the animalcules is placed in the aperture of that part of the hinge which is fixed to the slide, and which forms a sort of cell. The other portion of the hinge is then shut down on the fixed part, and this done, the slide may be placed under the microscope. Mr. Moginie's invention we have found both convenient and effective.

Microscope and Lamp-Stand.—In a recent number of the *British Medical Journal,* Dr. L. W. Sedgwick describes a contrivance for carrying both

lamp and microscope, which we should think must prove useful to the worker, and which is in principle the same as the table of Messrs. Loam and Fearns, which we some time since described and figured. It consists of a mahogany stand on three rollers, and provided with a lateral rod to which the lamp may be clamped. Its advantage in economising time will be apparent. Under ordinary circumstances, when the worker pushes aside his microscope, in order to continue some operation, he disadjusts the mirror for the lamp; and when he next uses the instrument he must spend a few seconds in obtaining readjustment. By means of either Dr. Sedgwick's or Messrs. Loam and Fearns' tables he may push away his microscope, and on drawing it towards him again find the adjustment the same as before.

Stereoscopic Binoculars.—Those who are at all interested in the principles on which the phenomena of binocular vision are at present considered to rest should read Dr. Carpenter's paper on the "Stereoscopic Binoculars" in the last *Quarterly Journal of Microscopical Science.* We cannot see that the modification of Nachet's stereoscopic binocular, which Dr. Carpenter describes, has any advantage over the ordinary binocular for the purposes of dissection; but we doubt whether our readers can find elsewhere than in the article we refer to a really simple and comprehensive account of the optical advantages and disadvantages of the binocular microscope.

Mr. Collins' Parabolic Reflector.—At the suggestion, we believe, of Mr. Bockett, Mr. Collins has constructed a parabolic reflector adaptable to his ordinary microscopic lamp, and which, from our examination, we feel much pleasure in recommending to our readers. The reflector itself is a silvered one of the usual parabolic form, but it is connected to a metal chimney which slides over the glass one, and has an aperture in the side opposite to the reflector. Thus not only may a very large and brilliant bundle of parallel rays be thrown directly on the mirror of the microscope, but all other rays being cut off, the eye feels a relief in the surrounding shade, such as it does not obtain with any other contrivance.

PHOTOGRAPHY.

Action of Light on Chloride of Silver.—The *Journal de Pharmacie* recently published an interesting account of experiments performed by M. Morren, of the Academy of Marseilles, to demonstrate the true action of light on chloride of silver. M. Morren sealed up an equivalent of chloride of potassium in a small bulb, and in another placed a proportionate quantity of nitrate of silver. A perfectly clean glass tube, about a foot in length and an inch in diameter, being provided, the bulbs were dropped therein, and the latter two-thirds filled with solution of chlorine in water. The tube was then hermetically sealed, and on being smartly shaken the bulbs were broken, and their contents reacting on each other produced equivalents of chloride of silver and nitrate of potash. When the tube thus prepared was exposed during many days to sunlight, it was found that the chloride of silver retained its whiteness until the water became decomposed by the chlorine acted upon by the light, and that it then assumed a red-brown

colour throughout its mass, commencing from the surface. On removing it from the light this colour gradually disappeared, and the chloride resumed its former aspect. The experiment, frequently repeated with the same tube, always produced the same result. The experiment shows the fallacy of considering that the chloride, when darkened by the action of light, must be decomposed into a violet sub-chloride of silver and free chlorine. One of the editors of the *British Journal of Photography*, commenting on the above, says: "It will be remembered that when chlorine acts upon water, hydrochloric acid is produced and *oxygen*. In M. Morren's experiments the only object on which the influence of this oxygen could be expended was the altered chloride of silver; and we learn from the second experiment that the colour of the changed compound was not violet but *brown*, indicating a different result from that which we are accustomed to observe under ordinary circumstances. But here it is not improbable that the oxygen may come into play, and the product be an oxychloride of silver instead of a simple sub-chloride; but if it be true that the oxygen can combine with this violet compound, it becomes a question how far oxygen may be essential in the ordinary printing process on plain salted paper. . . If this apparent consequence, derivable from the results of M. Morren's experiments, be proved, it would most materially alter our views, not only of the *modus operandi* of light on chloride of silver, but also those on toning and fixing."

Exhibition of Photographs.—The London Photographic Society recently opened a photographic exhibition gratuitously for one week in the Architectural Gallery, 9, Conduit Street, Regent Street. The collection, if not a very large one, was good; and considering that the exhibition was only advertised in the pages of the photographic serials, it attracted a very fair attendance of visitors. There was plenty of inartistic and tasteless work on the walls, but there were also some photographs of peculiar excellence and beauty, at the head of which, for such technical artistic qualities as roundness, relief, and perfection of light and shade, stood the works of M. Salomon, of Paris. Respecting the origin of this gentleman's startling and wonderful superiority, a controversy now divides our photographic brethren, some asserting that it is due to the negatives having been skilfully touched upon and improved by an artist, and others loudly and emphatically denying this, and attributing it solely to the superior taste and knowledge of artistic effect which M. Salomon, being a sculptor of repute, is supposed to possess. Our own opinion supports either of these views; and we, moreover, believe that, in addition to artistic skill exercised in both these ways, the larger portion of such excellences as we find in the French photographer's marvellously finished portraits is due to a degree of artistic treatment in the process of printing, the great value and power of which is little understood in this country. As superior for their expression of sentiment, feeling, and imagination, as M. Salomon's works are for the above qualities, were the photographic pictures of O. G. Rejlander, on the preparing and selecting of which for exhibition, however, a little more neatness and care might have been profitably displayed. Some very fine specimens of carbon-printing were exhibited by M. Cherrill, and some excellent landscapes by Mr. Frank Howard. Mr. Dunmore, a good and tasteful operator, seems to

have a singular passion for pigeons, and never to photograph a landscape until these birds appear in it. Mr. Ayling's architectural photographs were greatly admired. Bedford's works retain their old supremacy as landscape photographs; and Mr. Faulkner's pretty little portraits are still in the van. We think "composition photography," as it is called, a great mistake in the hands of such operators as Mr. H. P. Robinson, and we hope the *Athenæum* critique on the specimen he exhibited in this collection has at length brought conviction to him. As an attempt to deceive and seem what it could not possibly be, the specimen called "Sleep" is an utter failure, although it proves Mr. Robinson to be a clever photographer and excellent operator.

The Duc de Luynes' Prize.—In the year 1856 the Duc de Luynes entrusted a Commission with 8,000 francs, to be awarded as a prize to the inventor who should produce photographs in printer's ink, within three years of that time. Before the expiration of these three years, Mr. Pouncy claimed the reward for a process of producing prints in carbon, and received from the Commission 400 francs and a silver medal, in recognition of his progress towards the desired end. The Commission then agreed to make their final decision in 1864, and before that time arrived, Mr. Pouncy again claimed the reward for a process by which photographs were produced in printer's ink; but the Commission declined, as Mr. Pouncy tells us, to investigate his claim, and have since awarded the prize to M. Poitevin for a process which was in existence before the prize was founded, and with which the founder must have been familiar. Mr. Pouncy says to the Commissioners: "Your own decision in 1859 proves that you consider M. Poitevin did not merit the prize then; how can he merit it in 1864, without having produced any proofs differing from those he exhibited in 1859, the principles of which were wrought out before the prize was founded?" We think our countryman's question fairly entitled to a reply.

The Lens Award at the Paris Exhibition.—In our last summary we called attention to the dissatisfaction publicly expressed by Mr. Ross, the optician, with reference to the manner in which the awards were made for excellence in the manufacture of photographic lenses. Out of this has arisen a somewhat curious controversy. Dr. Diamond, the English Juror in this department, Secretary of the London Photographic Society, and editor of its journal, in reply to the assertion made by Mr. Ross—viz., that the lenses were never in any way tested, says: "We hesitate, of course, to charge Mr. Ross with a wilful misstatement, but his allegation that the awards in Class IX. were made without the lenses being examined and tested is altogether without foundation. *All* the lenses submitted to the jury for examination were carefully tested *by experts called in for that purpose, who worked in the* CIRQUE NATIONAL *in the presence of the jury. The decisions of the jurors in regard to photographic lenses were, in truth, made after an unusually careful test of the qualities of the various instruments.*" Mr. Ross, in reply, re-asserts that his case of lenses was never opened, and calls upon the gentleman who had charge of the keys to support this statement—and he does so. Dr. Diamond then refers Mr. Ross to the Secretary of the Juries, as a gentleman who can satisfy him as to the truth of his (Dr. Diamond's) statements. Mr. Ross acts upon this advice, and receives the following reply:—

"Paris Universal Exhibition.
"South Kensington, Oct. 16, 1867.

"SIR,—In reply to your letter of the 16th inst., I have to inform you that, so far as I am aware, no notice was sent to you respecting the testing of your lenses, nor is it now likely that they will be tested.

"I am, Sir, your obedient servant,
"J. F. D. DONNELLY, Capt. R.E.,
"Secretary to the Juries.

"Thomas Ross, Esq."

To this letter and Mr. Ross' further reply Dr. Diamond has refused publication, and so for the present the controversy ceases. This seems to be only another proof of the small value and little meaning we can attach to the awarding of medals at our great Exhibitions.

India-Rubber for Mounting.—Much attention has been recently given to a solution of india-rubber in benzole, for the purpose of mounting photographs. Its advantages are said to reside in the rapidity and ease with which it can be applied, the leisurely way in which the prints can be mounted, the certainty of adhesion, the absence of stains, its use as a preservative against the action of damps, and the complete avoidance of "cockling." It is also said to keep the varnish on the surface of a print in a better condition, and to give it a brighter and finer appearance.

Photographic Literature.—The *Photographic Notes*, one of the oldest of the photographic serials, will at the commencement of the New Year merge into a new illustrated weekly journal, to be called *The Photographer: a Scientific and Art Journal.* Amongst its contributors will be most of the best known photographic experimentalists, practitioners, and writers of the day. Thomas Sutton, B.A., George Dawson, the Lecturer on Photography at King's College, Major Russell, Mr. A. H. Wall, and others, are to be regular contributors; and in its list of occasional contributors will be found names which amongst photographers are familiar as "household words."

To Preserve Photographs.—Mr. Henry Cooper, jun., to whom photographers are indebted for many valuable suggestions, has recommended the use of a solution of parafine in benzole, with a small addition of gum dammar, dissolved in the same menstruum. He prepares the varnish by making two solutions, one of parafine dissolved in benzole, one drachm to the ounce, the other of one ounce of benzole and a drachm of dammar; three parts of the parafine solution are added to one of the dammar, and the varnish is applied with a tuft of cotton wool. In mounting prints thus preserved the fact of the varnished surfaces being repellant of water will suggest the kind of material required for mounting. For this purpose nothing perhaps could be better than the above-mentioned solution of india-rubber.

The Photographic Society of London has removed from King's College, and will hold its future meetings at the Architectural Gallery, Conduit Street, Regent Street, in which handsome and spacious building so many Art Societies now have their permanent home.

New Application of Electricity in Photography.—In Paris a very ingeniously-contrived piece of mechanism has been introduced, by which the cap of the lens is removed, at the expiration of a given time replaced, while at the

same time a bell rings to announce the completion of the exposure. The apparatus consists of a dial divided into certain spaces, under which a pendulum moves by electricity. This is attached to the camera, and when the operator has prepared his plate for exposure he places one of the hands of the dial at a certain point, and connects the pendulum, &c., with the galvanic battery; he may then go away, perfectly satisfied that at the time he has indicated on the dial the exposure will be terminated, and he will be summoned to remove the plate.

Photography in Japan.—We are informed, that in the city of Osaka, Japan, there are not less than forty native professional photographers.

Another New Dry Process.—The photographer-in-chief of the Abyssinian expedition will practice a new dry process, which he calls the coffee process — the preservative being an infusion of coffee sweetened with sugar. When the plate is removed from the silver baths it is washed with water, and afterwards treated with the coffee, and then set aside to dry, ready for use.

New Panoramic Apparatus.—The well-known photographer, M. Camille Silvy, has recently taken out a patent for a new panoramic camera, by which four views can be consecutively taken upon one sheet of sensitized paper, by means of cylinders within the camera, by which the paper is pressed into contact with the convex side of a curved glass during exposure, wound and unwound so as to expose the whole of the surface to the action of light in the four exposures. For military purposes this invention promises to be specially valuable.

New Pocket Camera.—Mr. Thomas Sutton, B.A., editor of *Photographic Notes*, has suggested a means of converting an ordinary opera-glass into a photographic camera, by simply removing, for the time being, its object and eye glass. A dark slide might be made, perhaps of metal, of the usual form, having a shutter without hinges. When it was required to expose the plate, the slide would be put into a thin metal case having a round hole in front, with a flange into which the open end of the opera-glass could be screwed. The back part of the slide-case should also have an aperture of the same kind and diameter, through which the image on the ground glass could be viewed when it was in the place of the slide. The lenses might consist of a pair of doublets of different focal lengths, and a portrait lens, by which the photographer would be enabled to take any class of subject, whether instantaneous or slow; and the three lenses would occupy but little room. The portrait lens would be about 1¼ inch clear aperture, and would act very rapidly. An elastic disc, covering the hole in the back of the slide-case with a small single lens about 2-inch focus, would enable the operator to focus and render the image visible. A pocket tripod stand could easily be contrived to go with the new opera-glass camera.

Plan for Preserving Negatives.—Mr. George Dawson has suggested an excellent plan for preserving negatives. After the negative has been thoroughly washed and dried, albumen is beaten up with a little hot water and applied to its surface with a large camel-hair brush. It is then set aside to dry in a place free from dust, and afterwards varnished with Newman's varnish.

PHYSICS.

A New Ozonometric Method.—At the meeting of the French Academy, on the 9th of December, MM. Berigny and Salleron presented a paper describing a new process they have adopted for the registration of the proportion of ozone present in the atmosphere. Instead of exposing the test-paper for twelve hours to the action of the air, and of comparing it then with a standard "chromatic scale," they place the paper in an instrument they have constructed which they term the *Chronozonometer*. This consists of a drum moved by clockwork, which unfolds the paper to the air with a definite velocity, and thus exposes it to atmospheric action in uniformly increasing periods. Suppose, for example, that this apparatus unfolds the test-paper with the velocity of a centimetre per hour; after twelve hours there will be a length of paper exposed equivalent to twelve centimetres. The first centimetre of the paper will have been exposed for twelve hours, the second for eleven hours, and so on to the last, which will only have been exposed one hour. If this strip of paper is plunged into water it will become tinged with a graduated scale of colour from white to dark violet. Here, then, the test-paper supplies its own standard of comparison; for, to take a rough example, if the twelfth centimetre be as deeply tinted as the first one, it will be evident that the proportion of ozone present in the air during the twelfth hour was as great as that present during the remaining eleven.—Vide *L'Institut*, Dec. 11.

Actinic Power of Absorbed Light.—M. Niepce de Saint-Victor, the celebrated French physicist, has recorded a discovery which is most unexpected, but which is only another illustration of the principle by which force is never lost. As the result of some late researches, he announces the extraordinary fact that porous or rugose surfaces which have been exposed to light have a definite decomposing action on salts of silver when placed in contact with them in the dark. It has been considered probable by many natural philosophers that phenomena like phosphorescence are due to the emission of light previously absorbed. Till M. Saint-Victor's discovery this hypothesis had little beyond vague speculation to support it, but now it becomes an established theory. The French *savant* has proved by various photographic experiments that pieces of pasteboard which have been exposed to the light give out actinic force in the dark, and may be employed in producing decomposition of silver-salts.

The Bessemer Steel Spectrum.—Father Secchi, who lately presented to the French Academy his fine memoir on the Stellar Spectra, compared the spectra of certain yellow stars with the spectrum produced in the Bessemer "converter" at a certain stage of the process of manufacture. The employment of the spectroscope in the preparation of this steel was begun a couple of years since, but the comparison of the Bessemer spectrum with the spectrum of the fixed stars has not, so far as we can remember, been made before. The Bessemer spectrum is best seen when the iron is completely decarbonized; it contains a great number of very fine lines and approaches closely to the spectrum of α Orionis and α Herculis. The resemblance, no doubt, is due to the fact that the Bessemer flame proceeds from a great number of burning metals. The greatest importance attaches to the analogy pointed out by

Father Secchi. Father Secchi suggests that beginners could not do better than practise on the Bessemer flame before turning their spectroscope on the stars. Difficult an instrument to conduct investigations with as the spectroscope undoubtedly is, the difficulty almost becomes perplexity when the student tries to examine stellar spectra.

A Discovery in Blow-pipe Analysis.—Those who use the blow-pipe in mineralogical operations should read a paper lately read by Herr Rose before the Berlin Academy. In this the German chemist states, that he has found that the opacity of the glassy bead, which is sometimes observed when the specimen has been slowly fused, and which was first pointed out by Berzelius, is due to the formation of crystals in its interior. These crystals are usually very small, and are best observed with the assistance of the microscope; but they are occasionally very large, and may be seen with the naked eye. Herr Rose has described to the Berlin Academy a practical application of his discovery, by which he was able easily to produce the three allotropic forms of titanic acid.—Vide *L'Institut*, Oct. 30.

Experiments in Actinometry, recently tried on Mont Blanc by the Society of Geneva, and reported to the French Academy, give results opposed to the conclusions formed by Prof. Forbes from his experiments on the Faulhorn.

The Spectroscope in Toxicology.—Mr. H. C. Sorby, F.R.S., who continues his investigations of animal and vegetable substances with the spectroscope, has been recently studying the spectra produced by the colouring-matters of such substances as belladonna, &c. At a late meeting of the Philosophical Society of Sheffield he read a paper on the application of the spectroscope to medical jurisprudence. In this he showed how great are the difficulties which meet the toxicologist in his efforts to prove a case of poisoning by belladonna. When the seeds are present, their form offers a fair guarantee, but they are often absent, and then proof of poisoning becomes a serious question. Mr. Sorby showed that the difficulty was obviated by the use of the microspectroscope. The spectrum of the juice of belladonna is very distinct, especially when the colouring-matter has been added to solution of carbonate of soda. There are one or two other vegetable juices whose spectra are somewhat similar, but these could be at once distinguished by an appeal to the general history of the case. A small fraction of a single berry is sufficient to produce the characteristic spectrum-bands of belladonna.

Magellan's Barometer.—In reply to M. Radau's assertion that the principle of the static barometer was well known to both Magellan and Maguire, Signor Secchi has published a contradicting note, in which he states:—1. Neither Magellan nor Maguire understood the true principle of the action of the static barometer; 2. They suggested apparatus quite impossible to construct, and which they failed to construct themselves; 3. The impossibility of construction explains why this instrument fell into oblivion.—*Comptes Rendus*, tom. lxv., No. 11.

The Crystallography of Potash Salts, and also of Oxalate of Ammonia, have been investigated by M. A. Brio, of Charkoar, who alleges that the tartrate of potash and oxalate of ammonia both belong to the rhombic system.

A Travell●'s Barometer.—Señor F. de Bruno has constructed an instrument which is intended to stand the rough test of travel. It is made of iron, and acts perfectly in all positions. It is not liable to injury from shocks.

Luminous Visibility of the Electric Spark.—Mr. Felix Lucas concludes, from very original theoretic considerations, that the luminous distance at which the electric spark is visible is greater than that of a permanent light, the apparent intensity of which would equal 250,000 times that of the spark. The light actually employed to illuminate our new lighthouses gives a brilliancy equal to 125 carcel lamps. An electric spark possessing the illuminating power of the 200th part only of a carcel burner, is superior as to its power of projecting light. Hence we can conceive the immense effect of a warning light composed of intermittent flashes of the electric spark proceeding from a strong Leyden jar battery. Mr. Lucas states that, in an experiment made in a laboratory, two apparatuses were established, one voltaic equal to 125 carcel lamps, and another spark-battery equivalent to only the 1-2000th part of a carcel wick. The photometer (such as is employed in the lighthouse administration) showed a marked superiority in favour of the spark.—Vide *Chemical News*, October 4.

The Barometrograph is the term given by M. Breguet to an application of the automatic principle of registration to the barometer. It consists of four metallic boxes, the upper and lower of which are undulated (the usual aneroid barometer); a vacuum is made in each of these boxes separately, and they are attached to a chain the movement of which is four times greater than that of a single box for the same variation of pressure. A steel spring of great strength acts upon these boxes in a contrary direction to the atmospheric pressure, and communicates with an indicating lever. The registration is effected on a cylinder which revolves by means of an ordinary clock; it makes a complete revolution in a week and carries a glazed paper, which is covered with lamp-black by being held over the flame of a candle; the extremity of this lever, very fine and pointed, traces a line of variations in a white streak. The periods (four times a day) are represented on the diagram by vertical lines, and the barometric readings by horizontal lines placed a millimètre apart, the arm of the indicator being so arranged as to mark the variations on the same scale as a common mercurial barometer. This instrument, says the Abbé Moigno, has none of the errors of the common aneroid barometer resulting from the great number of pieces, levers, articulations, gearing, connecting chains, and springs.

Variations in Electrolytic Powers.—At one of the meetings of the French Academy, M. Edmund Becquerel described certain experiments of M. Bouchotte on the electrolytic powers of the currents of the magneto-electric machine of the Atlantic Company. From the experiments it seems, that when the current sent by the commutator is always in the same direction, the electrolytic power is that of 144 Daniell elements with sulphate of copper; but when the current is alternate, as in the production of the electric light, the electro-motive power is *nil.*—Vide *Compte Rendus*, Nov. 4.

Practical Value of the Polariscope.—The practical application of the laws of polarisation of light in the case of the saccharometer is well known to our readers. The value of this instrument is, however, well demonstrated by an experiment recently carried out by M. Dubrunfant:—Two samples of West Indian sugar, No. 10, of the same shade of colour, and apparently of the same commercial value, after being submitted to the saccharometer, were ascertained to contain 93·00 and 88·00 parts of saccharine matter re-

spectively; of which only 88·63 and 78·17 represented the extractable sugar. Now the values of these two sugars, according to the usual method of judging by types, would have been the same in each case, at the rate of 54 francs 50 centimes per 100 kilogrammes, but with the aid of the molassometer, the values were ascertained to be, in the one case, at the rate of 54 francs 69 centimes per 100 kilos., and in the other, only 47 francs 25 centimes; so that an English sugar refiner, buying by colour, according to the Dutch system of types, would have paid, in one case, exactly 7·44 per 100 kilos. above its real value.—Vide *Journal of the Society of Arts*, Oct. 18.

Meteorological Value of the Storm-glass.—The camphor storm-glass is an instrument so popular among amateurs, and so liable to error in its predictions, that we are glad to lay before our readers a thorough *exposé* of its inefficiency as an instrument of scientific research. Mr. Tomlinson, of King's College—whose researches on camphor are familiar to most physicists—has written to the *Chemical News*, to say that, from the high praise given to the storm-glass by the late Admiral Fitzroy, he was led to examine the instrument with some care; and this is what he says of it:—"I made one on a large scale, in a quart bottle, placed it on the window ledge, and kept a journal of its behaviour during some months. The conclusion I arrived at was, that the storm-glass is not acted on by light, or atmospheric electricity, or wind or rain, &c., but solely by variations in temperature; that it is, in fact, a rude kind of thermoscope, vastly inferior to an ordinary thermometer, and has no meteorological value whatever." "My paper on the subject is printed in the *Philosophical Magazine* for August 1863. It produced a few remonstrances, to the effect that I had degraded a pleasing instrument to the level of a toy. I believe it to be, as you replied to your correspondent, only a toy, but it is a very pretty one, and exhibits effects of crystallisation of great beauty and variety. I generally have one hanging up in a back window, and it affords me pleasure to look at it and to show it to my friends."—See *Chemical News*, Nov. 1.

Curious Phenomena of Projectiles.—In some remarks to the Academy of Sciences, M. Dumas described some very curious experiments made by M. Melsens. By causing a leaden ball to fall into water from the height of about a mètre, M. Melsens found that the ball drew along with it twenty times its volume of air. This same ball projected several mètres, by powder, to the interior of a cylinder, filled with water, the two vertical openings of which are shut by diaphragms of plaster, introduced into the cylinder nearly a hundred times its volume of air. If the initial velocity is small, the hole is about the same size as the ball (11 millimètres); by increasing the velocity it is much enlarged in size, and when considerably increased the hole becomes enormous. It is impossible to assign the cause of the increase of the hole to the ball alone. Also, when the velocity of projection is excessive, there is a double border inside and outside, formed round the holes where the ball enters and quits.—Vide *Comptes Rendus*, Sept. 30.

A Thermometer for the Window.—Mr. Moginie of Messrs. Bakers, of Holborn, has contrived an ingenious modification of the ordinary thermometer, which may be found convenient by those who keep an instrument of this kind outside their window. The frame is somewhat wedge-shaped instead of quadrangular; by this means the observer on looking at the scale sees the

broad side of thread of mercury instead of the narrow side, as in the ordinary thermometer. The advantage being that the external temperature may be more easily read off than in the ordinary instrument.

ZOOLOGY AND COMPARATIVE ANATOMY.

The Domestic Cat.—In an article, as remarkable for its classical erudition as for its scientific importance, Professor Rolleston asks and answers the question—Are modern cats of the same species as the cats of the ancients? He concludes that the domestic cat of classical times was probably the Marten, one of the Mustela group, while, of course, he admits that our modern cats are genuine Felides. The evidence adduced in his extremely interesting paper goes to show that, in the classical period, the word γαλῆ was used by the Greeks to denote the Musteline Martes and Ferret, but not the Polecat probably, though probably the Genet; and that in later times, but not till later times, it was used also for the *Felis domesticus.* The word *mustela* does not seem to have been transferred together with the office, when the latter was handed over from the Marten to the Felis, in Italy. In the East the Felis took both the name and the work of the rival it supplanted. It did succeed in supplanting the Marten as the domestic mouse-killer, probably partly by virtue of its greater attachment to man and to place, partly by virtue of its less pronounced tendency to burglary and petty larceny, partly by virtue of its more even temper, and partly by its greater cleanliness and less offensiveness. The very points, also, in which as a wild animal it is inferior, make it superior as a domestic one to a musteline. Its constitution being less plastic it cannot fit itself as easily as they can to varying climates, and in many, as Rengger has shown of Paraguay, it cannot run wild. Its range of foods is more limited, and its faculty for, and its courage in adopting, new methods of purveying for itself, less conspicuous than theirs. Hence "the poor cat of the adage" being more dependent on man, has been obliged to render itself more useful to him than the Marten, and it has very successfully turned its inferiority to "commodity."—Vide *Journal of Anatomy and Physiology*, November.

Parthenogenesis in Psyche helix.—Herr C. Claus, of Marburg, has published a paper, of which an abstract appears in the last *Microscopical Journal*, to prove that the male of *Psyche helix* exists, and that therefore it is not unlikely that parthenogenesis does not occur in this genus. Our readers are aware that the case of *P. helix* was one of the "leading cases" in the history of Parthenogenesis.

The Development of Insects.—The period at which indications of the sex present themselves in the insect embryo is at present a point pretty sharply debated. Herr Landois, whose curious experiments on the eggs of bees we some time since referred to, concludes that the sexual distinctive characters are not present till after the embryo leaves it. This view of the development is seriously questioned by Von Siebold and others, who adduce numerous instances in opposition to Herr Landois' opinion.—Vide *Zeitsch. für Wissen Zool.*, vol. xvii. part 3.

Effect of Chemical Substances on Infusoria.—The experiments which have

been made by Herr Binz, and reported in the *Centralblatt* [No. 20], are of the highest interest. Herr Binz particularly examined the actions of these agents upon the Paramecium so commonly found in putrid infusions of hay. The infusion and the antiseptic were allowed to come into contact with each other on a glass slide, while he observed the result by means of a low magnifying power. Binz classifies the substances that injured the Paramecium into two groups:—1. Those that kill by producing osmosis; among which are chloride and hyposulphite of sodium, chlorate of potassium and alum. 2. Those that have a directly poisonous influence: among which are nitric, sulphuric, tannic, and acetic acids; creasote, permanganate of potassium, corrosive sublimate, iodine, bromine, chlorine, and quinia. Of the acids, acetic is the most powerful poison. Solutions of 1 part of corrosive sublimate in 1,500 of water, of 1 of iodine in 5,000 of water, of 1 of bromine in 12,000 of water, of 1 of chlorine in 25,000 of water, were poisonous. Quinia has also a powerful action on the Paramecium; 1 part in 400 of water produces instant death, and 1 in 10,000 kills in two hours. Strange to say, salacine does not injure this animalcule, even when employed in a solution of 5 per cent.; and a 1 per cent. solution of nitrate of strychnia produced no injury within two hours.

The Anatomy of Edible Bats has formed the subject of a splendid memoir by M. Alix, which was read before the *Société Philomathique* of Paris. The author described the structure of the *Pteropus Edwardsii*, a species closely allied to the celebrated edible bat of Java, *P. edulis*. The former species differs from the latter in being smaller and more slender, and in certain peculiarities of the hair.—Vide *L'Institut*, Sept. 18 and 25.

Cordylophora Lacustris abroad.—M. Van Beneden lately read a paper on this interesting fresh-water zoophyth before the Belgian Academy of Sciences. The cordylophora was first discovered by Professor Allman, now of Edinburgh, then of Dublin, in the Dublin canals. M. Van Beneden found it in canals in the neighbourhood of Ostend. He proposes to obtain its medusoids, and work out the problem of its development.—Vide *L'Institut*, No. 1760.

An Egg of Æpyornis has been presented to the Academy of Sciences at Paris by M. Grandidier. Having lately returned from Madagascar, he states that the eggs of Æpyornis are found on a plain at one side of the island, and at a height of several mètres above the sea-level. Strange that though numerous eggs have been discovered, the bones of this creature are rarely found. M. Grandidier supposed the egg to be that of *Æ. maxima*; but in a paper read before the Zoological Society of London on the 28th of November, Mr. G. O. Rowley expressed the opinion that the egg discovered by M. Grandidier belonged to a different species, which he proposes to name *Æ. Grandidieri*.

A New Group of Organisms, to which the name of Labyrinthulæ has been applied, has been described by M. Cienkowski. The creatures typical of this new family were found beneath the marine algæ which encrust the piles of the harbour of Odessa. The Labyrinthulæ are minute, orange-coloured bodies, forming reticulated threads which enclose spindle-shaped bodies. Cienkowski sums up their peculiarities of structure and development thus:—1. They present masses of cells which enclose a nucleus, and which increase in number by division, and possess a certain degree of contractility, and which now and then are covered with a cortical substance.—

2. These cells exude a fibrous substance, which forms a stiff and tree-like network, forming a branching frame-work.—3. The cells leave the mass, and glide in different directions along the frame-work to the periphery of the mass. The Labyrinthula cells can only continue their peregrinations when supported by this line of threads.—4. The moving cells unite in a new mass and become cysts, in which each cell is surrounded by a hard covering, the whole being held together by a rind-like substance.—5. After some time four small granules are formed from each cyst, which most likely become young Labyrinthula cells.—Vide *Microscopical Journal*, October.

A Rare Australian Parrot.—At a very recent meeting of the Zoological Society, Mr. P. S. Sclater, the enterprising and indefatigable secretary, called particular attention to a rare Australian parrot which is now in the Society's menagerie at Regent's Park, and which was presented to the Society by Dr. F. Mueller, of Melbourne. The species is remarkable for its nocturnal habits. .

The Walrus at the Zoological Gardens.—The walrus, of which the public have already heard so much, may now be seen at the Zoological Gardens. He is in the pond with the seals. His diet, on which he seems to thrive, is composed of fish and porridge. The addition of this interesting creature to the Zoological Society's collection is another instance of the admirable zeal which the present secretary displays in his management of the menagerie.

Is Hyalonema Lusitanicum a Distinct Species.—According to the recently expressed opinion of Dr. J. S. Bowerbank, it is not. Dr. Bowerbank, having conducted a microscopical examination of this species, which has lately been made into a distinct genus of [*Hyalothrix*] by Dr. Gray, states that it is not even specifically distinct from the *H. mirabile* of Japan.

Preparation of Snails' Tongues for the Microscope.—Mr. A. M. Edwards, of New York, publishes a method for the preparation of the tongues of molluscs such as Littorina, which are, as a rule, extremely difficult to "mount" satisfactorily. He uses a rather strong solution of caustic potassa, the strength of which he cannot exactly specify, as it must vary with the species under manipulation, some having ribbons of such strength that they will bear the very strongest solution, while others will be injured by immersion in a comparatively weak liquid. Into this solution, in a test-tube or other convenient vessel, plunge the whole animal; in the case of the smaller creatures, shell and all. The specimen may be fresh, or preserved in alcohol, but on the former the potassa will act most vigorously. He has found that one good way is to let the animal stand in the shell until it dies and begins to decompose, when it can readily be removed, and falls in pieces. The lingual ribbon, as a general rule, is not easily decomposed. Now either set the potassa solution, with the animal in it, aside for some days, or boil it at once. You will then find that almost everything dissolves and becomes "soap," except the shell and operculum, a few shreds of muscular fibre, and the prized lingual ribbon. Frequent washing with fresh water now removes all the alkali, and leaves the teeth clean and in perfect order. It can then be mounted in any preservative fluid which is miscible with water, and is best removed to alcohol, to be kept until it is mounted. To mount it, remove it from the spirit, and without drying plunge it in pure spirits of turpentine, in which it should be boiled for a

short time to drive off some of the alcohol. It can now be mounted in Canada balsam.—Vide *American Naturalist*, Oct.

The Animal Hospital at Bombay.—This institution, which is termed in the vernacular the Pinjrapal, has been described in a paper read before the Boston Natural History Society by Mr. W. T. Brigham. It seems that a space of six or seven acres of the heart of the city is inclosed and divided into wards for the reception of sick and helpless animals. Cattle, deer, horses, dogs, goats, monkeys, and even tortoises, have all their separate abodes. Fish, too, says the author of the paper referred to, rescued from impending death by the pious Hindoos, swam unmolested in their proper tanks. The animals are not treated surgically, but are simply fed and cared for by the attendants.

M. Donné's Recantation.—At the meeting of the French Academy of Sciences, on the 7th of October, M. Donné, who has so long and ably supported the heterodox hypothesis of spontaneous generation, cried Peccavi. He admitted that his latest researches, so far from supporting heterogeny, convince him of the accuracy of the views of his old opponent, M. Pasteur. M. Donné's last experiment consisted in placing eggs in water under the receiver of an air-pump, exhausting all the air contained within the sheil, then re-admitting the air to the receiver, and thus pressing water into the eggs. Eggs so treated, and shaken so as to mix the white and yolk together, gave no traces of organic life, though left unacted on for at least six months. However, the cause need not mourn; it has found an equally able and staunch advocate in M. Trécul, the eminent French botanist.

Bombyx Japonica.—An effort to introduce this oak-feeding species into Ireland has, we believe, been recently attempted; at all events a paper suggesting its introduction was recently read before the Royal Dublin Society, by Dr. De Ricci. There is this peculiar Hibernianism in the idea. The young maggots come into existence before the oak-leaves appear in Ireland. What would become of them in the meantime?

The Limbs of Ornithorynchus and Echidna form the subject of a splendid memoir, presented by M. Alix to the *Société Philomathique* of Paris.—Vide *L'Institut*, Nov. 27.

The Classification of the Rodentia on natural principles has been attempted in a paper read before the Academy of Science at Vienna by Herr Fitzinger. The author sums up all the anatomical characters in deciding the rank in the scale of each species.

The Saliva of Dolium Galea.—Signori De Luca and Panceri, of the Neapolitan Faculty of Science, announce, as the result of their inquiries, that the secretion of this well-known Mediterranean Mollusc contains a large proportion of free sulphuric acid, which they think the animal produces by its electrolysis of the sulphur compounds in sea-water. The following is the composition of the secretions in 100 parts:—

Free sulphuric acid	3·42
Combined sulphuric acid	0·2
Chlorine as chloride	0·58
Potash, soda, magnesia, iron, phosphoric acid, organic matter, &c.	1·8
Water	94·0
	100·0

The Skeleton of the Primates.—Mr. St. Geo. Mivart, of St. Mary's Hospital, has reprinted, from the *Zoological Transactions*, his admirably comprehensive monograph on the Skeleton of the Primates. Part I. is now before us, and treats of the appendicular skeleton of Simia. It extends over more than 50 pages 4to., and is illustrated by a multitude of large folding plates, on which are figured the several bones described in the text. These drawings are such as could only be produced by a most skilful artist working under the watchful eye of an able anatomist; the rough processes, depressions, and articular surfaces of the bones are reproduced with a fidelity which, unhappily, we too seldom find in osteological treatises. It is by essays such as Mr. Mivart's that the science of Comparative Anatomy may hope eventually for a solid unshifting basis—essays in which the cautious observations of an unprejudiced student are allied to a just appreciation of the law of homologies; features which the memoir presents in no ordinary degree. The elaborate character of Mr. Mivart's monograph may be judged by the fact that it contains, beside its descriptive portion, complete comparative measurements of the appendicular bones of three different sets of specimens, and one distinct variety. From his researches on the Orang, Mr. Mivart concludes that it is "one of the most peculiar and aberrant forms to be found in the order of Primates."

The Osteology of Insectivora.—Mr. Mivart continues his account of the Osteology of the Insectivora in a second paper, published in the *Journal of Anatomy.* The paper extends over forty pages of brevier type, and is accompanied by numerous wood-cuts.

The Limbs of Man and Apes is the subject of a third monograph by Mr. Mivart. This is reprinted from the *Philosophical Transactions*, is amply illustrated by a series of handsome plates, and contains comparative and absolute measurements, not only of the bones but of the various processes of the angles and of the bones, of all the genera, from Man to Cheiromys; in all thirty-one genera.

Blind Coleoptera.—The anatomy of certain species of beetles which inhabit caverns has been quite recently investigated by M. Lespès, who has sent an abstract of his memoir to the French Academy. The species are five in number, and belong to four different families. Three of them live in caves: *Adelops pyrenæus*, *Aphænops Leschenaultii*, and *Pholenon Lucrilhaci*; one lives in ant-hills: *Claviger Duvalii*; and the fifth is found at considerable depth in the ground: *Langelandia anopthalma.* In all five the eye is completely absent, there being not even the most rudimentary trace of the organ. The optic nerve is not present, and the cerebral ganglia, instead of possessing the arrangement in other insects, are represented by a pair of oval-shaped bodies, which lie parallel to each other. On the whole, the anatomy of these species is like that of the larva of certain species which are blind in their earliest stage of independent existence.—Vide *Comptes Rendus*, Nov. 25.

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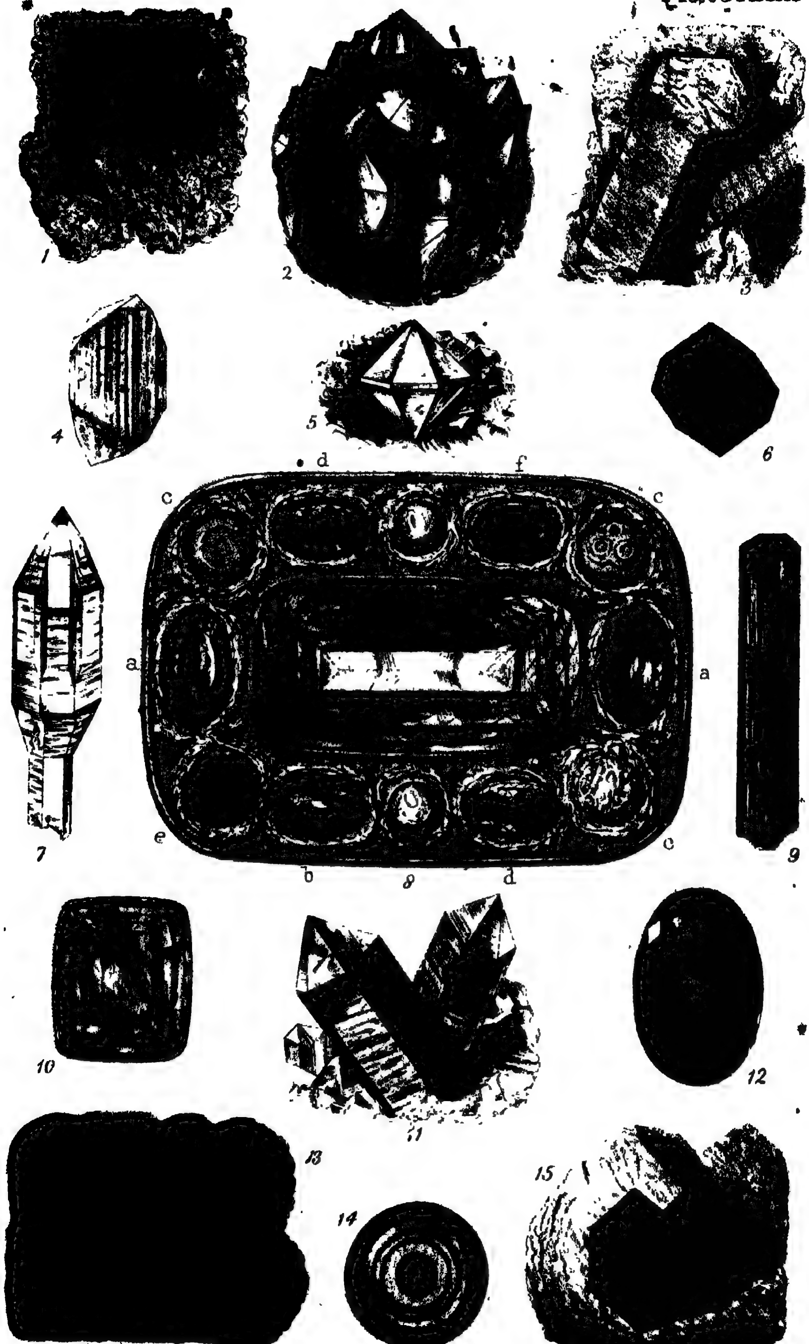
Plate XXIII



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British Gems

THE GEMS AND PRECIOUS STONES OF GREAT BRITAIN.

By J. MORRIS, F.G.S.

Professor of Geology in University College.

GEMS or precious stones are terms applied to certain minerals which, from their hardness, colour, transparency, lustre, or rarity, have been held in the greatest estimation from the earliest periods of the history of mankind. Prized for their beauty and scarcity, and significant of the wealth of the possessor, the precious stones were occasionally highly valued in different countries from supernatural properties being attributed to many of them, especially when engraved with talismanic figures or characters, from a belief that those persons who wore them or retained them in their possession, would be protected from the varied misfortunes of life, from certain diseases, and from the effects of poisons, or from the influence of evil spirits. Modified as the belief in their supernatural influence* has been by the onward progress of intelligence, some of these stones have been held in great esteem within a comparatively modern period, either as suggestive of certain facts or ideas, as commemorative stones, or as emblematical, from their colours, of certain virtues. From the numerous passages scattered throughout the Old Testament, the precious stones appear to have been early recognised, and used as valuable objects of decorative ornament. The pectoral or breast-plate of the high priest of the Jews was ornamented with twelve stones, which were intended to represent the twelve tribes of Israel. The stones were arranged in four rows, and consisted of the sardius or ruby, topaz, carbuncle, emerald, sapphire, diamond, ligure, agate, amethyst, beryl, onyx, and jasper. Two onyx stones were also engraved with the names of the tribes, six on each stone, and set in gold, and placed upon the shoulders of the ephod. Various uses, both ornamental and otherwise, have been made of precious stones. The trappings of the

* "Essay about the Origine and Virtues of Gems." By the Hon. Robert Boyle. London, 1672. Boetius, De Natura Gemmarum, 1690.

horses belonging to Maha Raja, one of the eastern princes, were estimated to have been worth an immense sum, besides which, on grand occasions, they were adorned with the finest jewels of the treasury, including the celebrated diamond the Koh-i-noor, or Mountain of Light. Among the Mohammedans, the cornelian is regarded as possessing many virtues, and is still further esteemed, from a saying attributed to Mohammed, that "he who seals with a cornelian, will always be in a state of blessedness and joy."

More than two hundred years ago, the Germans selected twelve stones as typical of the twelve months of the year, each stone bearing an engraved sign of the month. These stones were very fashionable, and many persons of both sexes wore, mounted in rings, the stone of the month in which they were born.* Thus:—January = Garnet; February = Amethyst; March = Bloodstone; April = Sapphire; May = Emerald; June = Onyx; July = Cornelian; August = Sardonyx; September = Chrysolite; October = Aquamarine; November = Topaz; December = Turquoise or Malachite.

The four rings sent by Pope Innocent III. to King John, contained each a different coloured stone, as emblematical of the cardinal virtues, faith, hope, charity, and good works, which were respectively represented by the emerald, sapphire, garnet, and topaz.

The fine stones, or gems proper, are generally transparent, and either colourless, red, blue, green, yellow, violet, or have a chatoyant lustre. They are amongst the hardest of mineral substances, either equal to, but mostly harder than rock-crystal; hence to some extent their value, and for this reason they are employed for the pivots of watches, and other instruments of precision. Another physical character connected with them is their comparative coldness to the touch, a test sometimes used to distinguish them from false or imitative gems; even quartz possesses to some extent this quality—a fact apparently known to the people of ancient Rome, who are said to have used balls of rock-crystal (such as those seen in the British Museum from Japan), for cooling their hands in the summer season. Similar small globes of rock-crystal have also been used as divining stones.

The crystalline forms which the gems or stones assume vary greatly, and may sometimes be used as a distinguishing character. The diamond, spinel, and garnet present various modifications of the cubical system; the sapphire, beryl, emerald, as well as quartz and tourmaline, belong to the hexagonal system; the topaz and chrysolite crystallise in rhombic, and the zircon

* Jackson: "Minerals and their Uses;" Emanuel on Precious Stones.

in square prisms. Connected with their forms is their refractive power: the diamond, spinel, and garnet, or the cubical stones, have only simple refraction; whilst all the others possess double refraction, and these latter present very interesting phenomena, when viewed in thin sections by means of polarised light, according as they possess one optic axis, as the beryl and zircon; or two optic axes, as topaz. A knowledge of the differences of the crystalline form of minerals, and of their relative density or specific gravity, is of great practical importance in distinguishing one from the other, as, for example, the so-called British diamonds from the real gem, or the false from the true topaz. Some minerals, however, used for ornament, are neither crystalline, transparent, nor very hard, as lapis lazuli, turquoise, and malachite.

Although several of the mineral species generally regarded as gems or precious stones are known to occur in the British Islands, and many of them, especially in olden times, were cut and polished for personal ornamentation, the extension of trade and commerce over the globe has tended to lessen the estimation in which they had previously been held, by the introduction of a supply of similar stones of infinitely finer quality from more distant parts.

Thus we have garnet, topaz, beryl, or emerald, sapphire (?), and the varieties of amorphous and crystallised quartz, as rock-crystal, amethyst, cairngorm, agate, onyx, calcedony, jasper, opal, &c.

In Great Britain these are generally found imbedded in the rock mass, whilst the valuable and most highly prized stones that come to us from abroad, are rarely obtained from the original matrix, but usually are found as grains or pebbles in ancient or modern alluvial deposits, the more perfect and solid ones only having resisted the wear and tear to which they have been subjected since they were eliminated from the breaking up of their parent rocks. Hence the comparative abundance of the precious stones in the river valleys which traverse the metamorphic strata, in which these minerals were originally imbedded, as in India, Ceylon, Australia, and South America.

The minerals and stones which occur in the British Islands, capable of being used for ornamental purposes, may be classified under the following arrangement:—

SILICA:	**Colourless:**	**Rock-crystal (so-called Bristol, Welsh, Cornish, and Irish Diamonds).**
Crystallized, or Quartz	**Yellow, Brown, Smoky**	**Cairngorm, or so-called False Topaz.**
	Violet=Amethyst.	

Amorphous .	Agate, Onyx, Sardonyx, Cornelian, Flint, Jasper, Heliotrope, and Opal.
Silicates . .	Kyanite, Disthene or Sappare, Iolite or the Sapphir d'eau, Zircon, Beryl, Aquamarine, Emerald, Felspar, Adularia, Green Felspar, Garnet, Almandine or noble Garnet, Olivine, Chrysolite, Serpentine (noble and common).
Boro-silicates . .	Tourmaline, Rubellite, Schorl.
Fluo-silicates . .	Topaz.
Aluminates . .	Sapphire, Spinel.
Fluorides . . .	Fluor Spar.
Sulphides . . .	Iron Pyrites.
Carbonates . .	Malachite, Marbles.
Sulphates . . .	Alabaster and Satin Spar.
ORGANIC MINERALS .	Amber, Jet, Cannel Coal.

Notwithstanding that all the minerals which are included in the above list (many of which are entitled to be considered as gems or precious stones), occur in Great Britain, still it is but rarely that specimens are encountered of sufficiently fine water or colour as to render them worthy of the labour of the lapidary. As proof, however, that such stones do occur, which, when cut and set, may present a very pleasing and ornamental appearance, we have in the accompanying plate figured an ornamental gold snuff-box, set with stones and pearls from Scotland, which was presented to the late distinguished geologist, Dr. Maculloch, by the Duke of Athol. This unique specimen may now be seen in the Jermyn Street Museum, where it forms part of that valuable and interesting collection.*

Amongst the most familiar mineral substances is quartz, which in its transparent and colourless form is termed rock-crystal. It is usually found occurring in crystals which are six-sided prisms transversely striated, terminated by similar faced pyramids, as shown in fig. 7 from Carlow, and fig. 5, Pl. XXIII. representing a crystal from the hematite mines of Cumberland, in which the lateral planes are scarcely visible. Its chemical composition is pure silica, and the specific gravity is 2·6.

Crystals of quartz are found in all parts of the world, and in rocks of all ages, both as forming part of the rock mass itself, or occurring in veins, cavities, and geodes of such rocks. In the latter cases it attains its finest development, often in crystals of immense size, and occasionally highly transparent. Such large and colourless crystals were formerly highly prized, and by enormous patience and labour were worked into various ornamental articles often estimated at fabulous prices. Although

* By the courtesy of the Director of this Institution, we are enabled to figure this box, which is said to have originally cost 100 guineas.

quartz does not possess that brilliant lustre which is due to the highly refractive powers of the diamond, still to the ordinary observer it presents an appearance so similar to it, that it is frequently mistaken for that gem.

In consequence of this, the purer quartz crystals have been extensively employed in jewellery, and thus have given rise to the names of Bristol, Cornish, Welsh, Irish and Bohemian diamonds, from the localities where the mineral occurs.

When the otherwise colourless crystals of quartz have a more or less pronounced hue imparted to them by other substances, we have a great variety of often very beautiful stones, largely used in personal decoration, such as amethyst, blue, rose, and aventurine quartz, cairngorm, &c.

The very beautiful and well-known stone amethyst is simply quartz coloured by a very minute quantity of oxide of manganese. This variety of quartz is invariably found crystallised in mineral veins or cavities of rocks, and frequently in geodes. In England it has been found of a fine deep colour at the United Mines and Wheal Unity in Cornwall, and in geodes or potato-stones in Somersetshire. In Ireland, at Achil Island, Mayo, in fine translucent crystals, occasionally attaining eight or ten inches in length, and several other localities. In Scotland it occurs in the Hebrides, in Lewis and North Uist, and in cavities of agate in Fife and Perthshire. The figs. 8*aa* and fig. 8*b* are specimens of deep and pale-coloured amethysts.

The name amethyst (*ἀμέθυστος*) was applied to this stone in consequence of the property ascribed to it by the ancients, and recorded by Aristotle, as a preservative against intoxication. Fig. 2 shows a small group of crystals in part of an agate geode.

The amethyst has always been a favourite stone independently of the many virtues attributed to it, besides that of preventing intoxication. It is known as the Bishop's Stone from its being worn as a ring by the Roman Catholic bishops, just as the green variety of tourmaline is said to be used as a ring-stone by the clergy of Brazil, from which country a large part of the amethysts used in jewellery are obtained. When of a fine and uniform colour, the amethyst is still perhaps as much esteemed at the present time as it was by the ladies of ancient Rome.

The yellow and brown varieties of quartz are in Scotland termed Cairngorm, from the celebrated mountain locality of that name, and which, from the earliest periods of Scottish history to the present time, have been regarded as ornamental stones of almost national character.

In the box (fig. 8), the central stone is a fine yellow cairngorm, whilst the entire bottom is formed of a plate of similar stone but of more pronounced colour. Fig. 10 is a representation of a beautiful specimen of a rich yellow-brown tint. Fig. 11

shows crystals of the variety called smoky quartz, which varies in colour from a very dark, almost opaque, to a light brown smoky tint. The colours of the varieties of smoky quartz and cairngorm are materially increased by exposure to heat, as in the example (fig. 12), a property frequently taken advantage of by jewellers when mounting such stones.

The cairngorm was invariably used as a decoration of the Highland dress. The breast-buckle, or brooch, from the earliest times has always been a favourite personal ornament in Scotland. Martin, in his work on the Western Isles, published in 1703, says: "I have seen some of the former of an hundred marks' value. It was broad as any ordinary pewter plate, the whole curiously engraven with various animals, &c. There was a lesser buckle, which was worn in the middle of the larger, and about two ounces in weight. It had in the centre a large piece of crystal or some finer stone, and this was set all round with several stones of a lesser size.'

Among remarkable relics of this kind is the Glenlyon brooch, which is circular, and of silver, richly jewelled; and the still more celebrated brooch of Lorn, dropped by Robert the Bruce after the defeat of his followers at Methven,* and alluded to by Sir Walter Scott in the "Lord of the Isles":—

> "Whence the brooch of burning gold,
> That clasps the chieftain's mantle-fold,
> Wrought and chased with rare device,
> Studded fair with gems of price."

Various other varieties of quartz, such as rose, blue, leek-green (prase), and aventurine quartz, are also met with in Great Britain, and might be employed in jewellery, although seldom found of much beauty.

The term Cat's-eye has been applied to a variety of quartz which possesses a peculiar opalescent structure, due to the presence of minute parallel fibres of amianthus imbedded in its substance. This variety, which in jewellery is always cut *en cabochon*, has been found in the Vale of Llanberis in Wales, and also in Scotland.

The varieties of silica in which crystallisation is not distinctly visible, form a large class of stones employed in the manufacture of the chief articles of personal decoration, and many of which are extremely pretty. These are generally classed under the term calcedony, which is translucent, and frequently found associated with more or less admixture of crystalline quartz. The reddish-yellow, brown, milky, and mottled varieties of calcedony are usually known as cornelian,

* Figures of these beautiful examples of the favourite Celtic ornament are given in D. Wilson's "Prehistoric Annals of Scotland," plates 2 and 3.

and are found in several parts of Great Britain, where they are employed in the making of inexpensive ornaments, brooches, crosses, seals, &c. The colour of cornelian is also rendered more intense by exposure to the sun or the application of heat. Other more common varieties, possessing a striped and sometimes brecciated structure, are known as Agate, and are called coralline, moss, ribbon, and fortification agate, according to the peculiarities of their internal structures. Such stones are often called Scotch pebbles, from being of very frequent occurrence in that country.

It may be here mentioned, that many of the stores called Isle of Wight and Brighton pebbles, and assumed to be collected on the adjacent beaches, are frequently proved to be agates, imported from Germany, and in some cases have been artificially coloured by processes long known to and learnt from the lapidaries of Italy.* The colours imparted to them are either yellow, blue, dark brown, chocolate, or black, frequently giving an onyx or even sardonyx appearance, due to the greater or less porosity of the layers of which the agate is composed, whereby they are penetrated by the colouring matters in different degrees. The stones are kept immersed in honey and water, or oil, for some time, and afterwards placed in sulphuric acid, which carbonizes the organic matter previously absorbed, and thus renders them brown or black according to the porosity of the stone (see fig. 14).

Many of the agates are of such great beauty, and so interesting when considered in relation to their mode of formation, that they are fully deserving of being illustrated and considered in a separate communication; a full description of them would be quite beyond the limits of the present notice. The stones in fig. 8 *ccc* are small examples of agates from Scotland.

Onyx and sardonyx, which consist of different layers of calcedony, have both been found in Scotland and Ireland, and have occasionally been employed in this country for cameos—a specimen of which, from the Giant's Causeway, so prepared, may be also seen in the Jermyn Street Museum. Some of the varieties of Jasper, which are agates coloured by much red oxide of iron, occasionally form, when polished, pretty ornaments.

The Bloodstone, or Heliotrope, stated to have been found in the Western Islands of Scotland and in Argyleshire, is a variety of calcedony which owes its deep green colour to an intimate admixture of chlorite (or delessite), whilst the blood-red spots whence it derives one of its names are due to the presence of the red oxide of iron. Even the common flints are frequently used, when cut and polished, as ornamental stones,

* Die Kunst Onyxe, &c., Noeggerath, Neues Jahrbuch, 1847, p. 473.

especially when they contain organic remains, such as sponges, choanites, ventriculites, &c., presenting often a very beautiful arrangement, due to the structure of these fossilised organisms. Flint pebbles of this kind are commonly found at Brighton, Dover, and the Isle of Wight, where they are derived from the wear and tear of the chalk cliffs in which they were originally imbedded.

Opal—a hydrated variety of silica—has also been found in various parts of Great Britain, where its commoner forms are not unfrequently met with. That beautiful gem, the fire opal, is stated to occur at several localities in Cornwall; but we are not aware that any British specimens have as yet been usefully employed in this country.

Disthene, or kyanite, from the Greek word signifying blue, is a mineral occasionally used in jewellery; it is a silicate of alumina, and occurs in thin bladed crystals generally imbedded in metamorphic rocks in some parts of the Highlands of Scotland, in the mica schist of Donegal, Ireland, and finely crystallized in the Shetlands.

Iolite is also a translucent blue stone, said to occur disseminated in granite and gneiss, both in Ireland and Scotland. This stone, when viewed in different directions, exhibits a change of colour, whence it derives the name dichroite.

Zircon, a silicate of zirconia, known as the Jargoon or Hyacinth, is said to be found in Scotland and Ireland; its hardness equals that of topaz, and its specific gravity is about 4·5.

Equally rare in Britain are the Corundum or Sapphire (pure alumina) and Spinel (aluminate of magnesia). The former is stated to be found in Donegal, Wicklow, and at Carrock Fell in Cumberland; and the latter, as rolled grains, in the auriferous sands of Wicklow. With the exception of corundum from Cumberland, there are no British specimens in the national collection.

Some varieties of felspar are occasionally employed in jewellery, as, for example, the opalescent Adularia, or Moonstone.

The stone in the box (fig. 8 *e*) is a polished specimen of Green Felspar or amazon stone.

The Beryl, Emerald, or Aquamarine, are names given to stones of similar composition, but which differ slightly in their colour and transparency. They are silicates of alumina, with a little glucina, and generally crystallise in hexagonal prisms with vertically striated faces, a character which often serves to distinguish them from quartz. Beryl is harder than topaz, but is scratched by sapphire, and has a specific gravity of about 2·6. This mineral varies greatly in colour; the pale green variety is called aquamarine, whilst the darker and more brilliant ones are termed emeralds. Beryls are found in small blue crystals, with topaz and tinstone, at St. Michael's Mount, and in well-

defined colourless crystals near Falmouth and at Lundy Island in granite. In Scotland, both in Banffshire and Aberdeen, large and nearly transparent crystals are sometimes found, usually of a straw-yellow or apple-green colour, and also in greenish-yellow crystals from Rubislaw, near Aberdeen.

Green beryl occurs somewhat abundantly in quartz veins traversing the granite, and also forming part of the granitic mass itself near Dungloe in Donegal, whence the specimen (fig. 3) was obtained. In fine blue crystals (fig. 9), from the Mourne Mountains, near Dublin, where it is associated with topaz, in which county, at Killiney and Dalkey, greenish crystals of some length have been discovered. The two specimens of aquamarine (fig. 8 *d d*), are from Scotland, where this variety occurs in the Cairngorm district.

The Garnet is a silicate of alumina, lime, magnesia, iron, manganese, &c., in very varying proportions, nearly as hard as quartz, with a specific gravity between 3 and 4, crystallises in forms belonging to the cubical system, usually in dodecahedrons (figs. 6, 15), and occurs as imbedded crystals in granite, gneiss, metamorphic schists, and limestones. The colour of this mineral is extremely variable, being all shades of yellow, brown, red, black, and even green; but the only ones used in jewellery are those of a light to deep red colour. The light ones are known under the name of Almandine, and the deep blood-red ones are the Carbuncle; the former being usually facetted, whilst the latter are cut *en cabochon*, with the lower surface frequently hollowed out, when the colour is very intense, as in fig. 8 *f*.

Garnet is probably the most extensively distributed of the British representatives of precious stones, although rarely found in perfection in sufficient quantity to be rendered available, or to compete with the finer and purer specimens of this mineral obtained from other countries. Occasionally, however, it is found of sufficient purity and colour to be cut and polished, as at Elie Bay in Fifeshire, where transparent crystals (pyrope?), fit for purposes of jewellery, are collected along the shore, derived from the adjacent trappean rocks, and known as "Elie Rubies." In many other parts of Scotland, and in the Shetlands, both the common and precious varieties are found. Garnet occurs in dolomite of a cinnamon colour, in Donegal, Ireland, and as brilliant red crystals near Dublin; also in Cumberland, Cornwall, Isle of Anglesea, &c.

Olivine, a silicate of magnesia—when of transparent yellow or greenish colour is known as Chrysolite, and used as a gem—is common in many of the British basaltic rocks: but we are not aware that it has been found in pieces sufficiently large and compact to admit of its being cut and polished.

Tourmaline, a boro-silicate of alumina, iron, &c., has nearly

the hardness of quartz, and the specific gravity is about 3. It is occasionally used as a gem when of yellow, green, or pink colour. This is, however, seldom the case with any of the British specimens, which are usually black, like that figured (1) from Bovey Tracey, Devon, where fine crystals are associated with apatite in granite, but are worthless for ornamental purposes. Tourmaline crystallises in modifications of six-sided prisms, deeply striated, terminated by three or six planes, and is remarkable for its optical properties. Like topaz, it becomes electric by heat or friction. It is also found in Scotland and Ireland.

The well-known gem Topaz (a fluo-silicate of alumina), is not uncommon in the granitic rocks of Great Britain and Ireland. In Scotland magnificent topazes have occasionally been found in Cairngorm, and one specimen is stated by Professor Jameson to have weighed nineteen ounces. "There is a peculiarity in the disposition of colour in the Scotch topazes; their prevailing hue is pale blue, but there is a tinge of reddish-brown along the acute edges of the prism."

The Irish topazes from the granite of the Mourne Mountains, associated with beryl, are usually colourless, but have sometimes a faint pink, blue, or green tinge. Small bluish-white crystals are found in the tin veins in the granite at St. Michael's Mount, Cornwall, and at Lundy Island. Topaz crystallises in rhombic prisms, longitudinally striated, as shown in fig. 4, has a specific gravity of 3·5, and by heat or friction becomes electric, like tourmaline. The colourless varieties of topaz, when cut as brilliants, are often used to imitate diamonds.

Lapis lazuli and Turquoise have not been as yet found in the British Islands; the only opaque stone of native production adapted for jewellery is malachite, or carbonate of copper, which is found at Redruth, Cornwall, the softness of which does not entitle it to rank as a gem, though otherwise it is much employed as a cheap ornament of personal decoration. Its beauty as a stone depends on its concretionary structure, showing zones of deep or pale-green colour, as seen in the specimen (fig. 13).

The various coloured fluor spars of Derbyshire are well known; and in that county also the fibrous variety of gypsum, or alabaster (sulphate of lime), called satin-spar, is also worked into beads for necklaces, and other similar ornaments, often very pretty, especially from the play of light which they exhibit.

The organic substances, bituminous shale, jet, and amber, were used for personal ornaments, as beads and necklaces, previous to the Roman colonisation of Britain, as they are found not only in the early sepulchral deposits, but in those of the Anglo-Roman period in many parts of Great Britain; jet being then highly valued, and even an article of export, according to Solinus, at that early period.

British jet is still much used for personal ornament in England; it is chiefly obtained from the liassic strata near Whitby, Yorkshire, where it occurs imbedded in various-sized pieces, due to the subsequent bituminisation and change of coniferous wood, which was entombed in the sea-mud of that period. Amber, or the fossil resin of coniferous trees, has been frequently found on the east coast of Britain, although the chief source of supply is from the southern coast of the Baltic, derived from the tertiary strata of that district.

"It appears accordingly to have formed one of the most favourite articles for adorning and setting brooches, hair-pins, and other personal ornaments, from the earliest practice of the jeweller's art, until our native tastes and customs were merged, by increasing intercourse with other nations, into the common characteristics of later mediæval art." *

Table of Physical Characters of Gems.

	Colourless	Red	Yellow	Green	Blue	Violet	Brown	Black	Hardness	Spec. Grav.	Scratches		Refraction	Electric	
											Quartz	Glass		By Heat	By Friction
Diamond	×	×	×	×	×		×	×	10	3·5	× ×	×	S †		
Sapphire	×	×	×	×	×	×			9	3·9–4	×	×	D		×
Chrysoberyl			×	×					8·5	3·7	×	×	D		
Spinel		×		×	×	×			8	3·7	×	×	S		×
Topaz	×		×	×	×				8	3·5	×	×	D	×	
Zircon	×	×	×	×			×		7·5	4·6	×	×	D		
Beryl	×		×	×	?				7·5	2·6	×	×	D		
Emerald				×	×				7·5	2·6	×	×	D		
Rock Crystal	×		×				×		7	2·6		×	D		×
Amethyst						×			7	2·7		×	D		×
Chrysolite				×					6–7	3·4		×	D		×
Garnet		×		×		×	×	×	6–7	3·8	?	×	S		
Tourmaline		×		×	×	×	×	×	6·5	3	?	×	D	×	
Turquoise				×	×				6	2·6–3		×			
Lapis lazuli					×				5·5	2·4		?			
Opal	×	×	×	×					6	2·3		?			
Malachite				×					3·5–4	3·9		0			

* D. Wilson: "Archæology and Prehistoric Annals of Scotland," p. 305.
† S. Single. D. Double.

NOTE.—Some of the specimens figured on the Plate have been kindly lent by Mr. J. Gregory and Prof. Tennant.

IS THE FRESH-WATER SPONGE (*SPONGILLA*) AN ANIMAL?

By JOHN HOGG, M.A., F.R.S., F.L.S., &c.

I HAVE lately read Professor W. C. Williamson's paper on that curious but very puzzling natural production, the *Spongilla fluviatilis*, in the last number (26) of the Popular Science Review, with much pleasure.

The author says, very correctly, "in common with its spongy relatives, its claim to rank amongst *animals* has been extensively questioned,"—although recent examinations of the marine sponges, aided by microscopes of high power, and modern perfection, have detected in the minute structure of some of the species a similarity, or affinity, in certain organic properties, rather to an animal, than to a vegetable, being. Still, admitting such an increase in our knowledge of these remarkable organisms—in the absence of any decided and generally received *proof* of animality—I am uncertain of the correctness of that view. Thirty years ago, I maintained the probability of certain marine sponges (*Spongiæ*) being of the nature of lower *animals*, whilst the *Spongillæ* and certain kinds of sea sponge, partook much more of a *vegetable* structure.

Even at this day, some distinguished naturalists retain the like opinion; and of these, I will only mention two, viz. Professor Agassiz and the venerable Professor Ehrenberg. The modern views of the last microscopist and acute examiner of the lowest infusorial beings, during the extent of a very long life, still lead to the conclusion of *sponges* possessing more of a vegetable than of an animal nature. In proof of this, I will refer readers to a translation of his paper, on the "Animal or Vegetable Nature of Sponges," 1866, published in the "Annals and Mag. Nat. Hist.," for June, 1867.

Ehrenberg there confirms my previously expressed opinion, that "the sponges themselves are without those decisive characters of independent animal bodies, which have been detected down to the smallest monads." And also that "the essential

characters of the sponges coincide without difficulty with those of vegetable structure, inasmuch as their supposed animal characters, automatic ciliary movement, swarming young (or locomotive gemmules), and spermatozoids, and some contractility, as also a movement of the juices, have been recognised in both kingdoms."

As to certain movements of the sponges, as in *Characeæ* and some of the *Algæ* or lower plants, I had long before attributed them not improbably to the action of endosmosis and exosmosis. So Ehrenberg observes: "If the sponges be animals, their nourishment must be conveyed from in front and without, through apertures capable of being closed; if they be plants, the nourishment must be supposed to pass from the root-like base outwards and forwards by endosmose and exosmose." And this action can, I apprehend, solve some other conditions of the sponges.

The learned author of the "Infusionsthierchen" very recently writes: "I see no inducement at present* to give up the opinion already repeatedly expressed by me, that sponges *cannot* be described as animals."

As regards myself, Professor Williamson says: "Mr. J. Hogg some years ago noted various phenomena, which led him to conclude that it (*Spongilla*) was a plant. He specially observed that its green colour was largely dependent upon the action of light—a plant-like feature which had much weight with him and those who, like him, believed the *Spongilla* to be a vegetable form." This fact certainly gave me strong cause for that belief; but I will also add that *other* facts, which are not named by the Professor, and which were developed in the examination of the river-sponge, tended likewise to the same view; and these were, the presence of starch granules in some specimens of *Spongillæ*, as recorded by Mr. Carter; also the existence of iodine in the sea-sponges; the disengaging of the numerous bubbles of gas (*oxygen*) under the brightest sunshine, by the living mass of *Spongilla*; and the green chromule, or colouring matter, of the river-sponge being so similar to that in green *Confervæ* and many other plants.

The numerous spicula of sponges, although of remarkable and varied forms, do by no means prove them to be of an animal nature, because the like crystalline minute particles, called Raphides,† are secreted in a great many vegetable sub-

* See *December* 1866, "Monatsbericht der Berlin. Akad. der Wissenschaften."

† Vide Lin. Trans. vol. xviii. p. 398, for a notice of Raphides and their composition. These vegetable crystals are chiefly composed of oxalate of lime, and magnesia; some occasionally of phosphate of lime. Also in others, carbonate of lime is present, and probably carbonate of magnesia.

stances. On this important subject, the reader may consult Mr. G. Gulliver's able paper, "On the Nature and Diagnostic Value of Raphides," pp. 568–582 of the POPULAR SCIENCE REVIEW for October, 1865. In addition to raphides, Mr. Gulliver has described other crystalline bodies that occur in abundance in a vast number of plants under the terms of "sphæraphides" and "crystal prisms." Nor are currents of water flowing from the oscules of sponges at times, when in a fresh state, sufficient in my mind to decide their animal character; because, in the masses of sponge, the presence of some parasitic animal, or infusorian, or other minute water-insect, may generally be detected.

But I think it unnecessary to enumerate any more examples of characteristics that botanists might consider as tending, with great reason, to demonstrate an azoïc, or *non-animal*, nature of these aquatic and remarkable lower organisms.

This question, then, need not be continued any further, because I maintain that the limits between the animal and vegetable kingdoms are more or less artificial, and cannot be well determined; for life in the lowest animal-being, and that in the smallest plant, cannot be sufficiently distinguished. But I have always held that the two chief characteristics of an animal are, without doubt, the muscular and nervous systems, which are wanting in a plant. I have already considered it to be useless any longer to dispute about the nature of sponges, and of the many like doubtful organisms.

At the meeting at Oxford, in 1860, of the British Association, I communicated a paper, "On the Distinctions of a Plant and an Animal, and on a *Fourth* Kingdom of Nature," in which I stated that in order to place those organic beings which are of a doubtful nature in a fourth or an additional kingdom, I "suggested one under the title of the Primigenal Kingdom—*Regnum Primigenum* continens Protoctista, i. e. *Protophyta* et *Protozoa*. This would comprise all the lower creatures, or the primary organic beings,"*—*Protonta*, from *πρῶτα*, *first*, and *ὄντα*, *beings*; or, as I preferred, the more expressive but less harmonious word, *Protoctista*, compounded of *πρῶτα*, *first*, and *κτιστά*, *created beings*, both Protophyta and Protozoa. This fourth kingdom would of course include all the sponge-beings (*Spongioctista*), and the like anomalous lower *ctista*, creatures or organisms.

As might have been expected, some slight objections were taken to these suggestions by the less scientific persons, and by those who had not carefully studied biology; and they con-

* See "Report of the Thirtieth Meeting of the British Association," p. 111.

sidered that a *Fourth* Kingdom was not desirable. Yet some of our own distinguished naturalists at the present day maintain a *Fourth* or a *Sub* Kingdom; and I may add that after a lapse of eight years since that paper was written, I am more satisfied with its desirableness and utility, and feel assured that after further consideration of the extreme difficulties of the primary questions of biology a *Fourth* Kingdom of Nature will be generally adopted. Reference may also be made to my last published notice on the sponges, which is a letter in the "Athenæum" for 1867, p. 160; and I cannot pass over Dr. J. E. Gray's useful "Notes on the Arrangement of Sponges, with the Descriptions of some New Genera," just published in Part II. pp. 492–558, "Proceedings of the Zoological Society" for 1867.

I must now proceed to mention briefly some of Professor Williamson's accounts of the *Spongilla fluviatilis*. With regard to "the labours of Mr. Carter," which are contained in several numbers of the "Annals and Magazine of Natural History," I cannot place as much reliance on them as some others have done, for many of his details are so contradictory, prolix, and uncertain, that it is difficult to ascertain his real views and the distinct facts of his observations.

Professor Williamson only detects *three* elements in the *Spongilla*, viz. *first*, "the investing jelly," which I have termed (See Lin. Trans. vol. xviii. p. 387, 1840) "the parenchymatous substance," now called by those who consider the organism to be an animal, "sarcode." But sarcode is more correctly applied, as originally by De Blainville, to certain polypes—"Sarconoides"—*Sarcoidea*, which has the same meaning as Lamouroux's "Carnoides," and which is given to the polypiferous *flesh*, or "carnode," or inner substance of the Alcyonia, Lobulariæ, &c., and which are admitted by every one to be true animal substances. *Second*, the "internal skeleton," consisting of anastomosing fibres with bundles of brittle spicula composed chiefly of silex; and *third*, the round "seed-like bodies." To these I will add a *fourth* element, namely, the transparent "investing membrane," or the "diaphanous pellicle" of Dr. Johnston, which envelopes the entire mass, and lines all the inner pores and oscules.

The Professor seems to place great dependence upon the observations of Lieberkühn with regard to the *Spongilla*. This German naturalist's memoir is of more recent date than my own notices on the same organism, which were published in 1840, in vol. xviii. of the "Linnæan Transactions." Lieberkühn's remarks, printed in Muller's "Archiv," 1856–7, are unfortunately not written in Latin, or in French, and being filled with abstruse technical terms and phrases are only comprehensible by those scientific persons well acquainted with the

more difficult German. There is another interesting monograph on the *Spongilla* (also subsequent to my memoirs) by Laurent, entitled "Recherches sur l'Hydre et l'Éponge d'Eau Douce," Paris, 1844, with a folio atlas of beautifully coloured plates, which Professor Williamson is probably unacquainted with.

Of the four constituent elements in the organisation of the *Spongilla*, I will here only further observe on the *third*, or the "seed-like bodies." This term I gave to them in 1838; they are synonymous with "Sporangien," or "sporidia,"—the "semina lentiformia" of Linnæus, the "Körner" of Oken, the "semences" of Lamouroux, the "granules" of Dr. Gray, the "eggs" or "ova," "ovaria," the "corps oviformes' of Dutrochet, the "ovules" and "spherules" of others. I believe Dr. J.-E. Gray was the first to show the *germinating* nature of these "granules, which he squeezed from the fresh *Spongilla*, and which formed a velvety mass through which visible fibres were shooting and gradually growing."* The like appearances were noticed by me in March 1838, and on Dec. 18 of that year, I exhibited at a meeting of the Linnæan Society some specimens of the yellow seed-like bodies, which I had kept in a glass vessel, and every one of them was covered with a white woolly substance which showed distinct cells or pores, as well as minute fibres or spicula. The reader will see in the Lin. Trans. p. 366, this account, and also fuller and more decided proofs of a repetition of the same experiment at p. 373, and which Dr. Johnston considered† as "leaving no doubt of the truly seminal (or reproductive) character of the sphærulæ."

Professor Williamson has represented these seed-like bodies in Plate XX. figs. 2, 7, 8, 12: fig. 7 being a single one magnified; this well shows the small dots, or short papillæ, covering the outer shell, and the central dimple, "which by desiccation contracts and becomes somewhat drawn in," and also its orifice. This last is called *hilum* (fig. 7, *a*), a scar, by the author, and likewise by Link and Raspail; although Gervais correctly thinks that it is not so, since the body itself has no pedicle or funiculum. Besides these numerous fixed seed-like bodies there are other reproductive minute corpuscules, which I have called the "locomotive gemmules" or "sporules." I first noticed these germ-like bodies on Aug. 12, 1838, and they appeared to me to be similar to what Dr. Grant, in 1826, terms the "ova" of sea sponges, which he had noticed as "swimming"‡ and gliding with regular motions; and which M. Dutrochet describes as "les *œufs* de l'éponge, animés de mouvemens spontanés comme des

* See "Zool. Journal," vol. i. p. 50, 1824.

† Johnston's "British Sponges," p. 551, 1842.

‡ For this account, consult Lin. Trans. vol. xviii. p. 379.

animaux;" and which Lieberkühn, thirty years afterwards, calls by the awkward appellation of "swarm-spores," and describes as swimming actively about in the vessel of water in which they were placed.

My own account of the locomotive gemmules in 1838 was as follows:—"They are minute, though some are less than others, and are plainly visible to the naked eye; they are white, of a somewhat globular or rather more oval shape, the lower or smaller portion being opaque, and the upper transparent and membranous. Their movements in swimming were no less astonishing than elegant: ascending from the sponge at the bottom of the water to the surface, floating gently on the surface, or traversing the middle of the fluid like a balloon in the air, or suspending themselves nearly in one spot, or whirling round and round, describing larger or smaller circles in the water, approaching or avoiding each other; but, when performing their quicker progressions, they move along on their sides with their rounder ends precedent. I put several of these germ-like bodies into a wine-glass full of spring-water, adding fresh daily to them; after a day or two their gyratory motions became weaker and slower, and at length they entirely ceased; then the bodies attaching themselves to the bottom and sides of the glass, and losing their original shape, became flatter, the transparent membranes of their upper portion disappearing, the white opaque portions alone were left, which, resembling minute specks, at the expiration of a few more days increased to such a sufficient size as to show, with the aid of a magnifier, that they are undoubtedly the rudiments of the *Spongilla* itself, and thus proving that they are its *reproductive* bodies or sporules."

The same glass, with the germinating specks or gemmules attached to it, was exhibited to the Linnæan Society in the same year. I could not determine whether these locomotive gemmules became identical with the fixed seed-like bodies, or whether the former are the real sporules, and the latter the sporidia. Mr. Carter states, that the locomotive corpuscules are impelled by *cilia* in their movements, and that they are merely ciliated forms of the seed-like bodies.

This question is still undecided; as also is that more difficult one, How do the very minute *cilia* put into rapid motion these gemmules, since no muscular apparatus has been detected in them, as it has in the like moving germs, or gemmules, of the Zoophytes?

Professor Williamson's plate does not give any representation of the smaller white locomotive gemmules, which are so elegant in their excentric movements. Fig. 13, one of the granules from the interior of the seed-like bodies (figs. 7 and 12), is dif-

ferent from its primary appearance, being too *round*,* and filled with the granular germs, whereas the locomotive gemmule is at first oval, having only its lower portion of an opaque white, which contains its reproductive or vital substance. These may be seen in M. Laurent's beautiful plates. I must, indeed, remark that the Professor's fig. 17 is good, and accurately shows how the "young *Spongilla*" is developed from a seed-like body, and much in accordance with my own description (at p. 373, Lin. Trans. xviii.).

Professor Williamson makes no mention of the currents of water, which at times are seen to enter into, and flow from, the living mass of the river-sponge; but, inasmuch as so many parasitical insects, infusoria, aquatic mollusca, &c., inhabit the substance, it is exceedingly difficult to know how far they cause the influent and effluent streams by their process of branchial respiration, and how far (if at all) they are effected solely by the sponge-mass itself. It is almost always the case that some small insect may be detected, either nestling in the pores of the *Spongilla* or burrowing at the base of the mass; and I have not unfrequently found in some specimens, many of the *Ophrydinæ* of Ehrenberg, embedded in the jelly, or parenchyma, of the mass. So, again, may some of the minuter *Amœbæ*, *Actinophrys*, or infusorian animalcules, be confounded with what Carter terms "cells," or sarcoids, or small detached ciliated pieces of "sarcode," assuming those forms. Professor Williamson admits this great difficulty, which I had long ago experienced in my earlier researches, unaided with a powerful microscope; and he well says: "Various infusorial animalcules find their way into the sarcode of *Spongilla*, which may readily be mistaken for essential parts of the organism." Lieberkühn's notices of numerous groups of "germ-cells," or "germ-granules," I am not as yet acquainted with.

In concluding these supplemental remarks on Professor Williamson's interesting account of the "Fresh-water Sponge," I may mention a recent handsome work on the "Sponges of the Adriatic," although it is unfortunately written in German. It is entitled, "Die Spongien des Adriatischen Meeres, von Dr. Oscar Schmidt," Leipzig, 1862–6, and is illustrated with many beautifully coloured plates. Also another ably illustrated monograph, "Les Spongiaires de la Mer Caraïbe," by MM. Duchassaing et Michelotti, published in Naturk. Verh. Holland Maat. Wet. te Harlem, vol. xxi. 1864.

Professor H. J. Clark (of Pennsylvania) remarks in his paper "On the *Spongiæ ciliatæ*," p. 133, "Annals and Mag. Nat.

* This fig. 13 seems to be meant for the *largest*, and more mature of the germ-like bodies (see Lin. Trans. xviii. p. 374.)

Hist." for February, 1868:—"I have been engaged, like others, for some time past, in endeavouring to clear up the *doubt* which prevails in the scientific community, in regard to the *nature* of the sponge. The question has been, is it an animal, or is it a plant? Bowerbank, the highest classificatory authority upon this subject for a long term of years, held that it was an animal; but his *bases* for this theory were such that they did *not* appear to offer a satisfactory means of finally *deciding* the dispute. The latter remark applies with equal force to the investigations of Lieberkühn."

It only remains for me to add, with regard to these lower organisms, or created beings (*ctista*), as also the Desmidieæ, some of the Infusoria, and Diatomeæ, and doubtful Algæ, and other *Protoctista*, that, by including them all in a *fourth*, or "Primigenal Kingdom," it prevents the unnecessary trouble of contending about their supposed natures, and of uselessly trying to distinguish the Protozoa from the Protophyta.

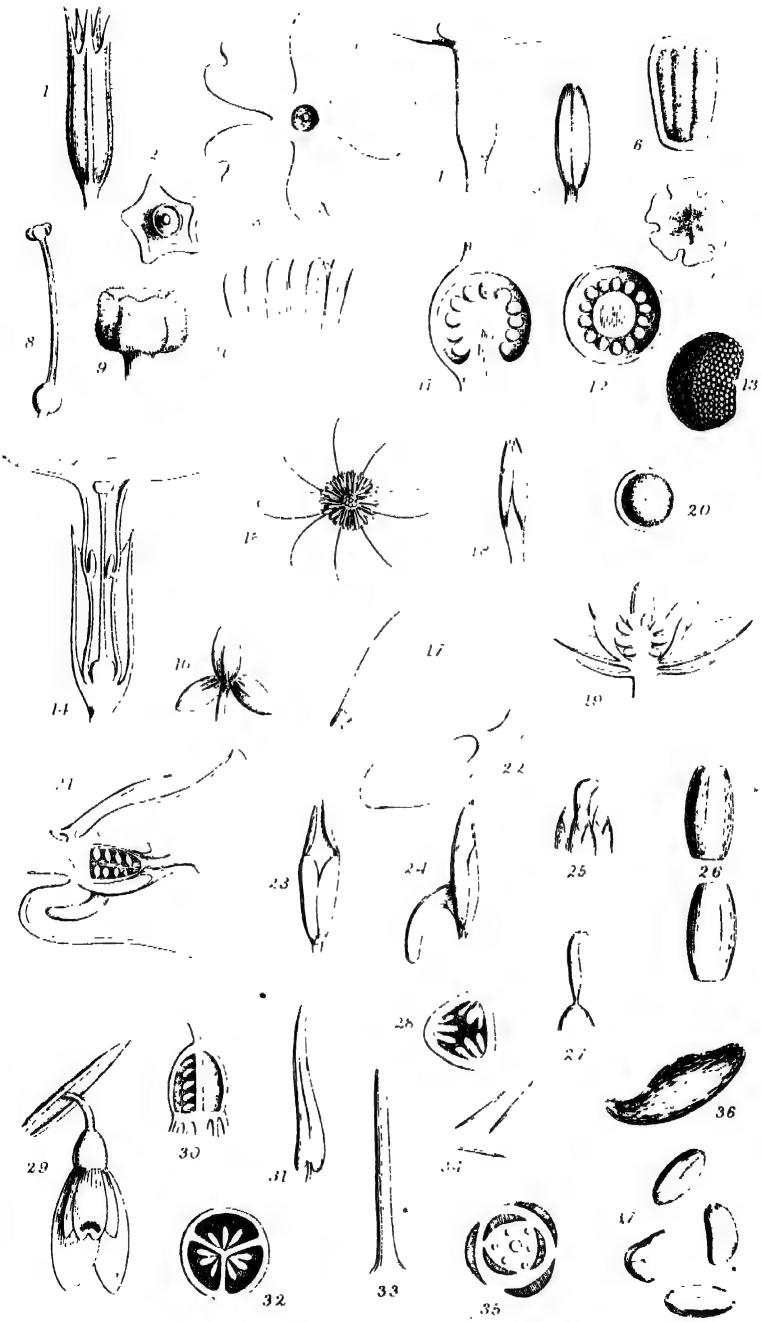
HOW TO DISSECT A FLOWER.

BY M. C. COOKE.

THE first flowers of spring always possess greater interest for us than the more showy and attractive floral beauties that grace the summer. The absence of wild flowers during the winter causes the opening of the first primrose or buttercup to be welcomed like the coming of a long absent friend. The snowdrop becomes the type of the resurrection of vegetable life, and the crocus with its "cloth of gold" prophesies of golden sunlight. Then we begin to think of the advent of the cuckoo, the sweet odour of the hawthorn, the twitterings of the swallows, and, unless we are very prosaic, dream ourselves into the summer unawares. But these early flowers have in themselves hidden beauty, order, and harmony, which are not apparent to every eye; and, if questioned closely, they will reveal their mysteries to the enquiring spirit. Even the primrose and the buttercup become of greater interest when better understood; and as a help towards this better acquaintance, it is our purpose to tear them in pieces, full of hope that in their destruction we may obtain wisdom.

There is not much mystery in the art of dissecting a flower; but, as in everything else, there is a method—a right way and its opposite—and method is not always intuitive. The requisite instruments are but few—the fewer and simpler the better; a multitude of tools is no evidence of the excellence of a workman. It may be that many who read these pages will be as familiar therewith beforehand as the writer, and marvel that he should not have told them more, or at least some new thing. Others will be glad of such a commonplace companion over a primrose, and with them the story begins.

A good clump of primroses, at least half a dozen flowers, is the first requisite, and the most important one. As we pluck one and hold it between the finger and thumb, turning it about in all directions, we observe that the stalk, or peduncle, which supports the flower, expands into a kind of long cup which holds within it the lower portion of the pale sulphur-



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How to Dissect a Flower.

coloured *corolla* (which in this instance is the coloured portion of the flower). The green cup, or *calyx*, is five-angled (fig. 1), and surmounted by five long narrow sharp-pointed teeth. In some other flowers—the strawberry, for instance—this calyx is composed of five little green leaves; but in the primrose the edges of these five leaves are united into a tube, with no other indication of the five leaves of which it is theoretically composed than the five sharp teeth, which are the apices of the leaves, and the five ridges (fig. 2, section) which correspond to the midrib of ordinary leaves. If these leaves of the calyx had been divided so as to have the appearance of five separate leaves, each of these would have been a *sepal*; but, as all are united, they constitute a monosepalous, or one-sepaled calyx.

In some flowers the sepals are all united at their edges into a monosepalous calyx. In others the sepals are distinct and form a polysepalous calyx. The primrose has a *monosepalous calyx*.

If we observe the flattened expanded surface of the flower, we can count five somewhat heart-shaped flower-leaves, which are notched at the outer margin, and united at the base, with what appears to be a little hole in the centre (fig. 3). If we fold together these flower-leaves, and, holding the stalk of the flower firmly in our left hand, draw from it the flower-leaves between the thumb and finger of our right hand, we shall be able to remove the flower-leaves, or corolla, in one piece from the calyx. We have now a cylindrical tube of an inch in length (fig. 4), with five lobes spreading nearly at right angles to it; and the hole in the centre, seen when looking down upon the flower, was the mouth of this tube. Had each of the five flower-leaves been separate, as in the strawberry, we could have plucked them off one by one, and each would have been called a *petal*; but as all are united together at the base, the primrose has a monopetalous corolla. It should also be observed that not only are the petals united, but also prolonged into a tube at the base, which is not the case in all corollas having the petals united.

In some flowers the petals are all united at the base into a monopetalous corolla. In others the petals are distinct, and form a polypetalous corolla. The primrose has a *monopetalous corolla*.

We must now for the first time seek the assistance of a knife. A sharp penknife will answer the purpose; but one of the small knives with a sharp point sold by opticians for the use of microscopists is better. Insert the point of the knife at the bottom of the tube of the corolla, just drawn from the calyx, and cut it open through its whole length. Lay the corolla upon a piece of sheet cork, about three inches square. Open the tube with a dissecting needle (any needle with the head fixed firmly

in a convenient handle), and, with small pins such as entomologists use, pin it open upon the cork. A little more than half way up the tube lie side by side five golden-yellow elongated little bodies, the full examination of which requires the aid of a lens. These are the *anthers.*

The anthers of a flower represent the male, or fecundating element, and in most instances consist of an elongated double sac, containing an immense number of minute bodies, variable in size and form in different species, called pollen-grains. When matured, the anther, or pollen-sac, ruptures throughout its length, or opens by valves, and the pollen grains escape. In the primrose the sac is ruptured longitudinally. It is worthy of notice that the primrose is one of those dimorphic flowers, in which the anthers occupy different positions in the tube of the corolla in different individuals. In some the anthers are placed a little more than half-way up the tube, in others they are arranged at the top, or orifice of the tube.*

The pollen grains are very minute, and in order to determine their form must be submitted to the microscope. Viewed by a $\frac{1}{4}$th or $\frac{1}{8}$th objective, they are found to be ellipsoidal (fig. 6), with six longitudinal ridges. The end of the grain is stellate (fig. 7), showing distinctly the six prominent ridges. Mohl, and afterwards Dr. Hassall, described the pollen grains of Primulaceæ as possessed of but three ridges, which may be true of some species, but certainly is not true of the primrose, for the ridges are distinctly six, and rarely seven.

The anthers are attached to the tube of the corolla by a very short filament. The number, position, and mode of insertion of the *stamens* (anther and filament combined) is of great importance in dissecting a flower. In order to observe the position of the stamens, it is only necessary to make a longitudinal section of the entire flower (fig. 14), and examine it carefully with a pocket lens of about one inch focus. If the stamens are to be removed, or any operation requires to be conducted in which it is desirable that both hands should be at liberty, a small metal stand may be purchased at an optician's, consisting of a stout brass wire fixed in a metal disc; the wire passes through the hole in the handle of the lens, fitting tightly, so that the lens may be elevated or depressed at leisure. By this arrangement the lens may be mounted on its stand and placed on the table before the observer in such a position that the flower when laid beneath it shall be in focus, and the operator has both hands free. By a little attention it will be discovered that the

* For further particulars on this subject, the reader is referred to Mr. C. Darwin's communication in the Proceedings of the Linnean Society, *Botany*, vol. vi. p. 77.

insertion of the stamens in the tube of the corolla is just opposite, in each instance, to one of the lobes of the corolla. Usually the stamens are alternate with the petals, or lobes of the corolla; hence this observation becomes of importance.

The centre of the flower is occupied by the *pistil.* In the primrose, a long slender filament with a pin-like head stands in the centre. When the stamens are half-way up the tube, they surround this filament, and the head reaches to the orifice of the tube. When the stamens are at the mouth of the tube, the head of the pistil, which in this flower is the *stigma,* only reaches partly up the tube, or as high as the place occupied by the stamens in the other form. If the pistil is traced downwards, it will be seen to originate from the top of the ovary. Thus the pistil consists of a *stigma* which forms the pin-shaped head, a *style* or filament which supports the stigma, and the *ovary* from whence it springs (fig. 8). As seen by a pocket lens the stigma will present a minutely hairy appearance (fig. 9), but the one-inch objective of a microscope shows that its surface consists of a multitude of delicate clavate hairs (fig. 10).

Finally, the ovary must be examined, and both transverse and longitudinal sections made. These sections prove in the present instance that the ovary is one-celled, and that a central prolongation of the axis supports the ovules. In a transverse section this central placenta occupies the centre of a circle of ovules (fig. 12). In a longitudinal section, it is manifest that this placenta does not pass through the ovary, so as to be continued in the style, but stops short, and the ovules are produced at its apex as well as around it (fig. 11). This axile placentation is very important, and would lead to a suspicion of the natural order to which the plant belongs in the absence of all other characters. The ovules themselves are very pretty objects under a one-inch objective, having a minutely granulated surface (fig. 13). The relative position of the ovary is another very important feature. In some plants the calyx is adherent to the ovary, and the corolla and stamens are attached to the top of the ovary. In such instances, the ovary is said to be *inferior.* In other plants the calyx is free from the ovary, and springing from beneath it the ovary is *superior.* The primrose has a superior ovary (fig. 14).

From the foregoing examination, therefore, we learn that the primrose has a tubular five-angled calyx, a regular monopetalous corolla, tubular at its lower portion, with five spreading lobes; five stamens inserted in the tube of the corolla, opposite to its lobes; a superior one-celled ovary, with a free axile placenta, and numerous ovules, and a capitate stigma. These are characters belonging to the genus *Primula* of the natural order *Primulaceæ*; and of this genus the primrose is a species.

The second flower selected for dissection is the Figwort, or Lesser Celandine as it is sometimes called, the *Ranunculus Ficaria* of botanists, and the earliest "buttercup" which makes its appearance. If seen with its yellow petals expanded, like a golden star (fig. 15), it will at once be recognised as a regular polypetalous flower, or, more correctly, it has a regular polypetalous corolla, for all its petals are distinct the one from the other. Turning the blossom over, and examining its under surface, we shall perhaps feel a little disappointed that a corolla .with eight or more petals should have a calyx of only three sepals (fig. 16), which are about half the length of the petals, and green. The sepals as well as the petals are free of each other, and therefore polysepalous. One by one we pluck off the yellow petals, and place them side by side upon a sheet of writing-paper, and having done so, commence examining them carefully with a pocket lens. At the base of each petal, on its inner surface, a small scale is attached (fig. 17); this is an important discovery, and must be carefully noted: very few flowers possess such a scale.

Returning to the remains of the flower from which the petals were plucked, a large number of stamens next attract attention. We remove them one by one, and finding more than twenty, are content to note that the stamens are indefinite. What a very singular plant this figwort must appear to the young botanist with its calyx of three sepals, its corolla of eight petals, and more than twenty or thirty stamens! It is customary for all these parts to agree in number, or if one has more than another, it is often twice or thrice, or some multiple of the typical number. Whenever such anomalies are found, therefore, they should be carefully observed. Of the stamens themselves little has to be ascertained. Their form is nearly clavate, the filaments about as long as the anthers, passing up between them for about one-third of their length (fig. 18). The pollen grains minute and spherical (fig. 20).

It is interesting to examine one of these stamens under the microscope, with a magnifying power of about 300 diameters, and to trace amongst the hexagonal cells the single central bundle of spiral fibre, running nearly to the apex of the anther.

The petals and stamens being removed, all that remains within the calyx is a nearly globose cluster of small pear-shaped green bodies, occupying the place of the pistil (fig. 19). These are in reality an aggregation of pistils; separate them, or cut the mass through in any direction, and they are proved to be a cluster of one-celled ovaries, each containing a single ovule, and surmounted by a distinct spot, which is the sessile stigma. There is no style, but the stigma occupies the apex of the ovary.

The lower portion of the ovaries when viewed under the microscope is seen to be thinly covered with delicate transparent hairs. Of course the ovaries are superior.

It needs no botanical knowledge or experience to detect many and important differences between the structure of the flower of the figwort and that of the primrose. Difference in the calyx, difference in the corolla, in the structure and position of the stamens, in the pistils, in the ovaries; in fact, in almost every particular, except that the ovaries are superior in both. In comparison with our last example, or indeed with any buttercup, we would recommend the student to seize the opportunity in the autumn of dissecting the flower of the common bramble, and carefully compare notes on the structure of the flowers of buttercups and brambles, as well as the mature fruit of both. Such an examination cannot fail to impart silent instruction.

The sweet violet (*Viola odorata*) has a flower differing so much from the preceding, that a brief sketch of its dissection is desirable. A first glance will detect both calyx and corolla, the former consisting of five equal green sepals, and the latter of five petals, of which four are nearly equal, and the fifth or lower one unequal. If the four upper petals are removed one by one, the form of the fifth will be better seen. It is not easy to remove the fifth petal entire (fig. 22), for a reason which will be hereafter apparent. This unequal petal is produced backwards into a kind of pouch or spur, passing between and beyond two of the sepals of the calyx, which are thereby extended. If a section of a complete flower (fig. 21) is made with a sharp knife from the base outwards, passing through the centre of the spur, the whole structure may be viewed with a pocket lens. The sepals are attached, not at the extreme base, but a little above it, and the lower petal forming a kind of bag or pouch, into which a horn or spur protrudes from the centre of the flower. Each sepal and each petal being unconnected to its neighbour, the violet is therefore polysepalous and polypetalous, but it must not be forgotten that the corolla is irregular.

The stamens will be observed to stand so close together that they touch each other, and form a kind of tube around the ovary (fig. 25). A dissecting needle or the point of a knife will remove them one by one, and as thus removed, they should be placed side by side upon the table at which the operator is seated. Five stamens, and all with very short filaments—or rather, apparently so, for the filaments pass along the back of the anthers, and are continued above them in a sort of triangular crest (fig. 23). All the stamens are thus crested, and three are alike; but two others of the five have a spur which is prolonged backwards (fig. 24), and enters the pouch of the lower petal. The stamens, therefore, are irregular, two of them being

spurred. The pollen grains are small, and require the microscope to determine their form, which is elongated, with convex sides and truncated extremities (fig. 26).

The style is club-shaped, hooked at the apex with the stigma on the under surface (fig. 27). As it stands, surrounded by the stamens, the hooked apex alone is visible (fig. 25). The ovary, it will be observed, from the longitudinal section of the flower (fig. 21), is superior and somewhat conical, bearing the ovules from each side. If a transverse section of the ovary is made, it will appear slightly triangular in outline, with the walls thickened a little into three equidistant placentæ, on which the ovules are produced (fig. 28). The ovary is undivided, and therefore one-celled, with three parietal placentæ, or placentæ of the wall of the cell. Comparison of the ovary of the primrose with the ovary of the violet will show that they both agree in the ovary being superior, and in being one-celled; but they differ in the ovules of the primrose being borne from the centre, and in the violet from the walls of the ovary. Moreover a comparison of other parts of the flower will exhibit differences in the calyx, in the corolla, in the stamens, in the style, in the stigma, and in the pollen granules. Prominent above all will be the distinction between the monosepalous calyx of the one and the polysepalous calyx of the other, and between the monopetalous regular corolla of the one and the polysepalous irregular corolla of the other.

The snowdrop (*Galanthus nivalis*) will serve as another example of flower dissecting; and in this instance we have also a common and familiar object upon which to perform our operations. The first superficial observation will be sufficient for us to note the entire absence of a green calyx, which is present in so many flowers. Instead of a calyx, we appear to have white petals. Let us strip them off carefully, one by one. There are three white floral leaves standing in a circle around the circumference of the flower; but beneath these are others, and smaller ones, notched at the apex, and ornamented near the notch with a crescent-shaped green spot (fig. 29). These may also be removed and placed beside the others, and are again three. So that we have three outer petals, which correspond to a calyx, only that they are white, and three inner and smaller ones, corresponding to a corolla. If the scars left by the removal of these flower-leaves are examined closely, the three inner are seen to be alternate with the three outer. Or, if a flower is cut transversely a little beyond the green ovary, we shall observe much such an arrangement as is indicated diagrammatically in fig. 35. The six floral leaves constitute what is termed a *perianth*; for although there is no green calyx, the outer circle manifestly orresponds therewith. The difference in form, size, and colouring

in the two sets of floral leaves is very distinct; whilst in the tulip, for example, the difference can scarcely be detected. It must be remembered that in this examination the *single* snowdrop is under inspection, and not the cultivated form known as the *double* snowdrop.

In some flowers having a perianth of this character, one or more of the petals have a form that differs from the rest, as in orchids, and such a perianth is called *irregular*. In the present instance, although the petals and sepals differ in size and form, they are alike in each series, so that the snowdrop has a *regular* perianth.

Within the perianth are six stamens, or two series of three in each, and all of the same length. Three of these are opposite to the three outer segments or sepals, and three are opposite to the three inner segments or petals. The filaments are short and the anthers are long, two-lobed at the base, and attenuated upwards to a sharp point (fig. 31), opening by a longitudinal fissure on the inner face. The pollen grains are irregular in form, mostly elliptical, often curved, with a longitudinal groove (fig. 37). Their surface appears to be smooth.

The centre of the flower is occupied by the pistil, which is slightly attenuated upwards, and not surmounted by any visible head, knob, or projection (fig. 33). Only the apex has free capitate cells, with a more distinct head than the hairs of the stigma in the primrose. These are only to be seen with a high power under the microscope. If the style is squeezed flat in a drop of water between two strips of glass, a number of small crystals (raphides), slender, and pointed at each end, will be set free (fig. 34).

To examine the ovary it will be necessary to make two sections—one longitudinally through the entire flower (fig. 30), and one transversely across the ovary (fig. 32). The longitudinal section will show that the ovary is inferior, bearing upon it the stamens and petals; it will also exhibit the axis passing quite through the ovary, and not stopping short as in the primrose. It will not be easy to cut through the ovary in such a manner that the ovules will be seen on both sides of the centre. The reason of this will be more obvious when a transverse section is made. A section of the latter kind shows that the ovary consists of three cells, each of which contains ovules attached to the centre or axis (fig. 32). The ovules are elongated, beaked at one extremity, and with a minutely reticulated surface (fig. 36). Numerous ovules are contained in each cell.

To summarise the results of this examination, we discover that the flower just dissected has a regular perianth with six segments, of which the three inner are smallest, and notched. The stamens are six, sharp-pointed, all of the same length,

opening along the inner side. The ovary is inferior, three-celled, with many ovules in each. The style is single, and not capitate, or cleft. We did not observe the other portions of the plant, which should also be taken into consideration, if we desire to determine its name and position, otherwise we should have discovered that its leaves and flower stalk were developed from a bulb, and that we have been examining the flower of an endogen, which we might have suspected from the typical number being three instead of four or five, as exemplified in the three outer and three inner segments of the perianth, the twice-three stamens, and the three-celled ovary. The botanist would unhesitatingly refer our "snowdrop" to the natural order *Amaryllidaceæ*.

Having dissected four flowers of very different structure, it will not be difficult to perform the same operation upon the same general plan with flowers belonging to twenty other natural orders. We may observe that we have only proposed to ourselves the dissection of the literal "flower" or blossom; other parts of the plants have been wholly disregarded. Even the fruits, important as they are to understand fully the distinctions between certain groups, have not been alluded to. Content to pluck a flower in full bloom, dissect it, and seek distinctions between it and other flowers, we do not desire to convey the impression that the other portions of the plant are of no value in the determination of genera and species. Our object has been to indicate how the "flower" may be dissected, and how much may be learnt by comparison of the results of the dissections of various flowers.

From the foregoing examples it will be seen that the features requiring particular attention are whether the sepals and petals are united or distinct, and whether regular or irregular; the number and mode of insertion of the stamens; the position of the ovary with respect to the calyx, whether superior or inferior; and in what manner the ovules are borne in the ovary, whether the latter has one or more cells. All these queries must be solved with every flower, and although these alone will not be wholly sufficient, they are essentials.

In the third volume of this REVIEW (p. 358) the Rev. G. Henslow explained a very simple and useful method adopted by the late Professor Henslow for obtaining the results of the dissection of a flower. To this communication we would refer our readers as a supplement to our present observations. Some such plan will be useful, almost indispensable, if the examination is to be of permanent value; and in that paper many terms are explained, which the space at our disposal will not allow of repetition here. How to dissect a flower, and how to record the results of such a dissection, are intimately associated; and

if the efforts made to explain both processes should tend to a closer acquaintance with our beautiful wild flowers, and to increase the number of botanical observers, both writers will be gratified.

EXPLANATION OF THE PLATE.

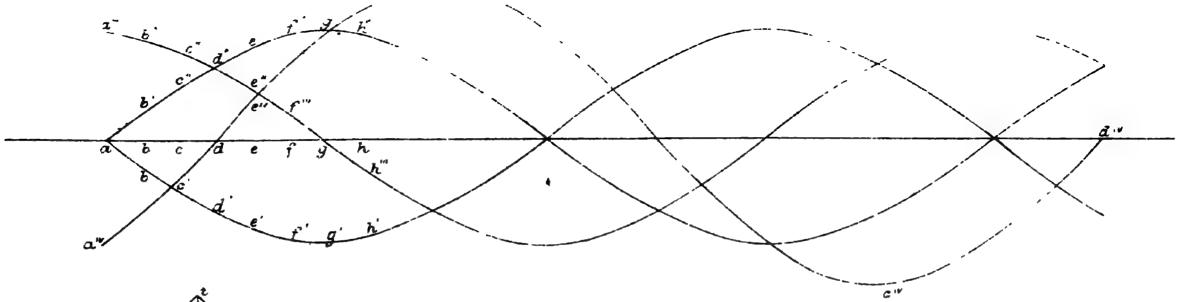
FIG. 1. Calyx of Primrose (*Primula vulgaris*).
,, 2. Transverse section of flower above the ovary, enlarged.
,, 3. Upper view of corolla of Primrose, showing the segments.
,, 4. Side view of tubular corolla of the Primrose.
,, 5. Stamen of Primrose.
,, 6. Pollen grain of Primrose × 360 diameters.
,, 7. Upper view of pollen grain of Primrose × 360 diameters.
,, 8. Pistil of Primrose, showing ovary, style, and stigma.
,, 9. Stigma of Primrose, magnified.
,, 10. Stigmatic surface of Primrose × 360 diameters.
,, 11. Longitudinal section of one-celled ovary of Primrose (enlarged).
,, 12. Transverse section of the same ovary.
,, 13. Ovule of Primrose × 60 diameters.
,, 14. Longitudinal section of entire flower of Primrose.
,, 15. Upper view of flower of Figwort (*Ranunculus Ficaria*).
,, 16. Under view of calyx of the same.
,, 17. Single petal of Figwort, with scale at its base.
,, 18. Stamen of Figwort.
,, 19. Longitudinal section of entire flower of Figwort.
,, 20. Pollen grain of Figwort × 360 diameters.
,, 21. Longitudinal section of entire flower of Violet (*Viola odorata*) enlarged.
,, 22. Lower saccate petal of Violet.
,, 23. Crested stamen of Violet.
,, 24. Spurred stamen of Violet.
,, 25. Pistil surrounded by the stamens.
,, 26. Pollen grains of Violet × 360 diameters.
,, 27. Pistil of Violet with the stamens removed.
,, 28. Transverse section of ovary of Violet.
,, 29. Flower of Snowdrop (*Galanthus nivalis*), with sepal removed.
,, 30. Longitudinal section of ovary of Snowdrop, enlarged.
,, 31. Stamen of Snowdrop.
,, 32. Transverse section of ovary of Snowdrop, enlarged.
,, 33. Pistil of Snowdrop, enlarged.
,, 34. Raphides from pistil of Snowdrop.
,, 35. Diagrammatic transverse section of Snowdrop, showing position of its parts.
,, 36. Ovule of Snowdrop × 60 diameters.
,, 37. Pollen grains of Snowdrop × 360 diameters.

THE POLARISCOPE, AND HOW TO WORK WITH IT.

By C. HOCKIN, M.A.

THE object of this article is to describe and to attempt an elementary explanation of the more ordinary phenomena produced by the polariscope. The results that are to be obtained with this little instrument, with very little trouble, are exceedingly beautiful. Perhaps an idea of the difficulty of understanding the subject has prevented the polariscope being so popular as many other scientific instruments. Of course, much labour and knowledge is required to study successfully the laws of the motion of light in crystalline bodies, and the relation of these laws to the shape of crystals. But few, we think, who possess a micro-polariscope appreciate its value. If we can awaken the curiosity of such to further research, we shall have attained our object, and we think they will be amply rewarded for their trouble by the beauty of the results obtained.

A figure of a very convenient form of polariscope, known as Nürenberg's, is given at fig. 1, Pl. XXV. AB is a plate or plates of clear unsilvered glass, supported, like an ordinary mirror, by two pins L and M, which fit rather firmly into circular holes in the pillars CD, EF. An index and sector at L enables the plate AB to be set at any angle with the vertical. The feet of the pillars CD, EF are fixed in a circular base, and between them is a round horizontal mirror. On the top of CD, EF is the annular frame of wood RS. In this frame turns another ring of brass, and supporting the pillars GH, KI. PQ is a plate of glass darkened at the back with some unreflecting substance, as lampblack. AB is called the polarizer, PQ the analyser. A thin glass plate covering the aperture between H and K serves as a stage to support the object to be examined. The plates PQ, AB are ordinarily set to make an angle of $33\frac{1}{4}°$ with the vertical. A ray of light coming in the direction XY will strike AB at an angle of $56\frac{3}{4}°$, will be reflected down to the mirror Z, then, passing vertically back through the plate AB to PQ, will finally be reflected in the direction UV (UV being a line in the same vertical plane as ZU, and making, with PQ, the same angle as



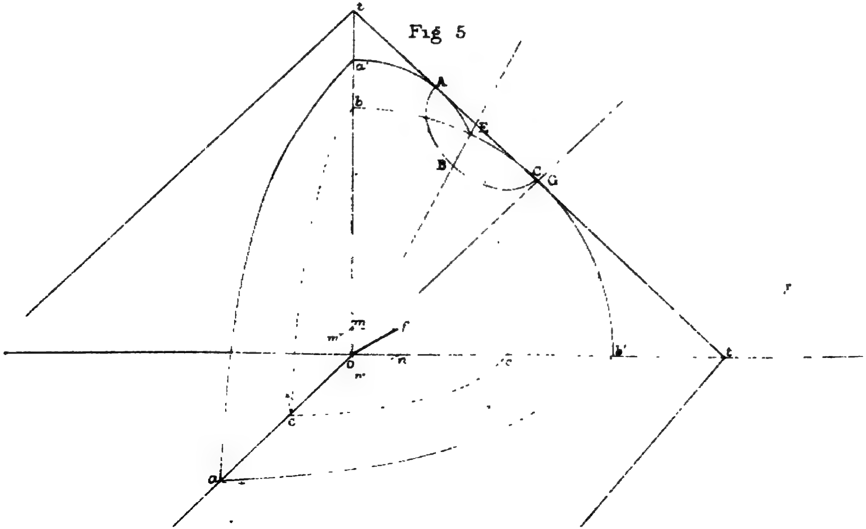


Fig 5

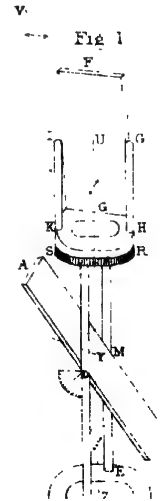


Fig 1

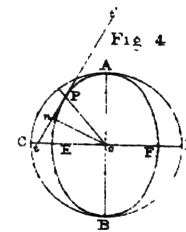


Fig 4

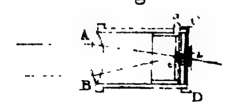


Fig 6

does Z U). Also the light coming from Z strikes P Q at the same angle as that at which it was before reflected by A B, namely, at $56\frac{3}{4}°$.

The brass ring supporting the pillars G H, K I enables the plate PQ to turn bodily round the vertical axis Z U. The rim B S is graduated to determine the angle between L M and G I.

A bright object placed at Z will be seen by an eye at V in the direction V U, and will, as is well known, appear equally bright, as the mirror is turned on its axis, in all positions of the mirror. If, however, the object is removed to a position in the line Y X, so that the light coming from it must be reflected by A B before it can fall on the mirror Z, and thence to the eye at V, it will be found that the brightness of the image seen in P Q by the eye at V will depend on the position of the mirror P Q. When P Q, A B are parallel, the image of the object at X is seen bright. As P Q is turned, the image gets darker, until P Q and A B are, as in the figure, at right angles to each other. In this position the image disappears entirely, and P Q looks perfectly black. On turning P Q further the image reappears, and again attains its maximum brightness when P Q has revolved through half the circle. On completing the revolution of P Q the same phenomena are repeated, the image disappearing when three-quarters of the circle are completed. The only difference between the light coming from Z direct and that coming from X is that it has been reflected in the second case by the glass plate A B. We see that this reflection has given to the light peculiar properties. It is no longer capable of complete reflection by P Q, except in two fixed positions of P Q, and is totally incapable of being reflected when the latter mirror is placed in a position half way between those it occupied when the whole of the light was reflected. It is from these properties connected with direction that light possessing them is termed polarized light.

Various means of producing polarized light will be described. This of reflection at the surface of a transparent substance is the simplest. To completely polarize the light, the tangent of the angle of incidence must be equal to the refractive index of the medium. Light consists, there is no doubt, of the undulatory motion of the particles of an ether, which is present wherever light passes. And further, the motion of each particle of light is perpendicular to the direction in which the wave is travelling, as is the case in the vibrations of the stretched string producing a musical note.

An idea of the nature of polarized light may be gained, perhaps, from fig. 8. Suppose $a\,b\,c$ to represent a line of particles at rest. Suppose a stream of light to pass in the direction $a\,b\,.\,.\,d$. The particle a first begins to move, then b, and so on. If a, b, c, &c. describe the same path over and over

again, the light is said to be polarized. It is plane polarized if each particle moves backwards and forwards in a straight line. After a has performed a whole number of paths, the form into which $a\,b\,c$ will be thrown is $a'\,b'\,c'$ . . .

Before describing the methods of producing the beautiful colours so well known to be produced by the polariscope, it will be necessary to say something of the laws of refraction of light in crystals, and of the interference of waves.

And first as to plane polarized light.

Suppose $a\,b\,c$ (fig. 8) to be a line of particles in their position of rest. If a wave of light polarized in a plane through $a\,b\,c$, perpendicular to the plane of the paper, be set up, the particles will, after a has performed a whole number of oscillations, lie in the line $a\,b'\,c'$ . . . If a had not begun to move until half the time of a vibration after it really started, the particles would have occupied the position $a\,b''\,c''$ . . .

The case we shall have most frequently to examine is that in which two causes exist, each of which would alone produce a set of waves such as $a\,b'\,c'$ . . ., of the same length and of the same height. In this case the effect of the two causes together is sum of the three separate effects. That is to say, if the two causes coexist, one of which would throw the particles into the position $a\,b'\,c'$ . . . at a given time, and the other would throw them at the same time into the position $a\,b''\,c''$ . . ., the effect of the two causes together is to leave them all in their original position, $a\,b\,c$ . . . For the position of any one, as d, is found thus:—The first wave would lower d to d', the second would raise it to d''; the two together bring it into a position found by first drawing a line upwards as high as $d\,d''$, and then measuring downwards a distance $d''d$, equal to $d\,d''$. It is clear that, as $d\,d'$ is equal to $d\,d''$, and $e\,e'$ equal to $e\,e''$, all the particles will, at every moment, be in the position of rest.

The wave $a\,b''\,c''\,d''$ is said to be retarded by half a wave length, that is to say, to be half a wave length behind $a\,b'\,c'\,d'$ . . . It is sufficiently clear that if $a\,b''\,c''\,d''$ is moved forwards half a wave length, that is, this distance a, the curve $a\,b''\,c''\,d''$ would cover the curve $a\,b''\,c''\,d''$ at every point.

We see then that two waves, one of which is retarded by half a wave length, produce rest, or, in the case of light, darkness.

A more exact representation of the case most frequently occurring is this:—The wave $a\,b'\,c'\,d'$ differs from $a\,b''\,c''\,d''$ only in depressions in one existing instead of the elevation in the other. We may look on the three waves in two lights; either we may say that they are both similar waves, one of which is behind the other (in a different *phase*), or we may say that one is a positive wave (producing elevations and depressions), and the other a negative wave producing depressions and elevations

at corresponding points; and then the waves $ab'c'd'$ and $a''b''c''d''$ are to be reckoned in the same phase. So that two equal waves, one positive and one negative, in the same phase produce darkness or rest.

Suppose we wish to find the effect of a given set of positive waves together with an equal set of negative waves, the latter $\frac{1}{4}$ wave-length behind the former. Draw the positive set $a\,b''c''d''$, and another positive set, $a\,b'''c'''d'''$, $\frac{1}{4}$ wave-length behind the first. The latter are to be reckoned negative, and we must therefore subtract the motion caused by the second from that caused by the first.

To find the resultant, consider the particle b. The first positive wave would raise it to b''; the second wave, if positive, would raise it to b'''; if the second set is to be reckoned negative, we must raise the particle to b'', and then lower it to b_4, where $b''b_4$ is equal to $b\,b'''$. The resultant wave is $a_4b_4\ldots$ Therefore a positive wave, together with a negative wave $\frac{1}{4}$ wave-length behind, produce a positive wave 1·4 times higher than either, and $\frac{1}{8}$ of wave-length before the first, or we may call it a negative wave $\frac{3}{8}$ of a wave-length behind the first.

This case is important for this reason. We shall have to consider cases of this kind.

Waves travel in one medium, so that the motion of every particle is parallel to of (fig. 5). Suppose of the height of the waves. They then enter a medium in which the motion must be parallel to either of the two lines ob or ob'. The wave, the vibrations of which are along of, will, on entering the medium, be broken up into two waves, the vibrations in which will be equal to om or on, and parallel to these lines. These will travel on independently of each other. Now, suppose they meet with another medium, in which the vibrations must be parallel to $m'\,n'$ perpendicular to of. Draw $m\,m'$, $n\,n'$, perpendicular to $m'\,n'$. The motion in the third medium will be the sum of the two waves whose heights are $m\,m'$ and $n\,n'$. mm' and $n\,n'$ are equal, and in opposite directions. They will therefore produce darkness unless the waves om, on have travelled with different speeds, so that one of them is behind the other on reaching the third medium. In that case we have seen that the light may have any intensity between darkness and the sum of the light due to each set of waves. For we should have stated that the intensity of light is proportional to the square of the extent of vibration of each particle, or, which is the same thing, to the square of the light of the wave.

When a ray of light enters any crystal not of the cubical system, it is divided into two rays which pursue different paths. One of these rays is refracted according to the same laws as hold for glass, water, &c. This is called the ordinary ray. The other is

refracted according to some other law, and is called the extraordinary ray. In the other class of crystals, termed biaxal, the two rays both obey a new law, different from those before-mentioned.

In a perfectly homogeneous medium a disturbance at any point will produce a wave spreading in a spherical form. A stone dropped in water produces circular waves—the form of waves in media the particles of which are arranged symmetrically with regard to certain directions, only the waves are not necessarily spherical.

In uniaxal crystals the arrangement of particles is symmetrical round the axis. In biaxal it is symmetrical in three lines at right angles to each other. These axes are called axes of elasticity, because if a particle is displaced a little in the direction of an axis of elasticity, it will tend to return to its place along the same line as that in which it was displaced.

Let A B (fig. 4) be the axis of an uniaxal crystal, C D any line perpendicular to the axis; A B, C D are axes of elasticity. If a disturbance take place at O, a section of the form of the wave will be as represented. A D B C is a circle, and A F B E an ellipse, and the whole figure is obtained by supposing fig. 4 to revolve round A B, tracing out a sphere and a spheroid. In some crystals C D is longer, in others shorter than E F. By a wave of a form of this sort, consisting of two separate sheets, it is meant that the motion of any particle of the ether is the sum of the motions of two waves of forms A C B D and A E B F. The motion of any particle of ether at P will be this kind. A ray traversing O P will consist of two waves, one polarized in the plane of the paper, the other in a plane perpendicular to this, and parallel to O n, normal to the ellipse at P. In consequence of the first wave, P will describe short excursions from its position of rest perpendicularly above and below the plane of the paper. In consequence of the second it will perform small oscillations in directions P t, P t'. Also as the spherical wave reached P before the spheroidal wave, the later waves will be a certain number of wave lengths behind the first. In biaxal crystals, which possess these axes of elasticity only, the form of the wave is complex, and it is difficult to draw a figure to give an idea of it. If O a', O b, O a are axes of elasticity, the eighth part of the surface, which is symmetrical with regard to the principal planes, will be of shape shown in fig. 5. The section by the plane a' O b' is a' c a, a portion of an ellipse with semi-axes O a' and O c, and b' b, a quadrant of a circle of which O is centre. So a a', c c' are quadrants of circles, and b' c, a' b of ellipses. The surface, therefore, consists of two sheets—an exterior sheet a a' E b', and an interior sheet c c' b E: these converge to a sharp point E.

A line parallel to O E, and a line O E$'$ in plane b O b', and inclined

to O a' at same angle as O E, are called optic, or ray axes of the crystal. Another peculiarity of the surface is that a plane $t\,t'$ parallel to O c, touching both the arcs a E, E b, will touch the surface at every point of the circle A B C.

Returning to the polariscope (fig. 1), we have seen that by turning P Q at right angles to A B no light is seen. If, however, a plate of a doubly refracting medium of proper thickness is placed on the stage K H, the light will generally reappear, and by turning the plate of crystal round, a position will be found in general in which the light is brightest. If the light falling on A B is white light, the crystal will also be beautifully coloured. Then, by turning the plate P Q round its axis, the colours of the crystal will change. Selenite is a crystal easily obtained, and producing these colours very well. A lamina should be detached by a sharp knife. The lamina should not be too thin or too thick. A plate about as thick as a sheet of ordinary paper, 200 leaves to the inch, will give a beautiful rose pink colour in one position of P Q, changing to a bright green in the opposite position. This plate, if split a second time, will give a bright blue colour, changing to gold-yellow. After one or two trials it is not difficult to find the best thickness of the plates to produce these colours. Tints of brilliancy and beauty equal to those produced in this way when A B is illuminated by the light of a white cloud are not to be produced, perhaps, in any other way. Instead of selenite mica may be employed.

To explain these results we suppose selenite employed. Imagine O $a'b'$ (fig. 5), the stage of the polariscope (fig. 1), Of parallel to LM (fig. 1), and $m'n'$ parallel to GI. Two axes of elasticity in this crystal are in the plane of the lamina, and one axis of elasticity is therefore perpendicular to the plane. Oa'E b' represents the form of the wave surface.

The light coming from Z (fig. 1) falls perpendicularly on the surface OA$'$E b' (fig. 5), and causes two sets of waves through the crystal parallel to the incident wave, one travelling with a speed proportional to Oc', and the other proportional to Oa, one polarized in plane Oab' and the other in plane Oaa'.

The vibrations coming from Z are wholly parallel to Of, and these are resolved in the manner described above in speaking of the interference of waves; that is to say, into waves the vibrations of which are parallel to Ob and Ob'. Of these the first set of waves travels the fastest, and first gets out of crystal; the second coming out after the first, will be a certain number of wave lengths behind it. When these sets of waves reach P Q that portion of the motion only will be preserved which is parallel to G I (fig. 1), or $m'n'$ (fig. 5). We have fallen then on the curve (fig. 8) before explained. The intensity of the light

reflected by P Q will depend on the thickness of the crystal, on the direction o*f*, and on the angle between o *f* and *m′n′*.

Returning to figure 1, the light in Z U is polarized in the plane of incidence; that is, each particle moves backwards and forwards in a straight line parallel to LM or DE. In like manner all the light reflected from PQ must consist of vibrations parallel to IG. It is easy to see that a motion parallel to LM cannot give rise to a motion at right angles to it, parallel to IG; and so no light is reflected by PQ when LM, GI are at right angles. The reason why the light reflected from A B at the particular angle stated before must consist of vibrations perpendicular to the plane of incidence is not easy to explain in an elementary way. Suffice it to say, that the experimental truth has been satisfactorily explained, first by Fresnel, since more completely by Green and others, to whose works we refer our readers.

The reason of the colouring is that the red light being made up of waves of greater length than the blue or yellow light, of the two waves into which red light is split up in the crystal, the one travelling slowest will be behind the other on coming out of the crystal, by an amount of space depending on the thickness of the crystal and on the difference of speed. This space will be a smaller fraction of the wave length in the case of red light than in that of blue light, and therefore when these waves have been reflected by the analyzer, and that portion of the motion of each is preserved which is parallel to GI (fig. 1), the two waves of red light to be compounded (as in fig. 8) will differ in phase by a different amount, in the cases of red light and blue light; and the intensity of the resultant wave will also be different in the two cases, or the light will be coloured. These phenomena are complicated by the fact, that the speed of light on one colour is not the same as that of another colour in the same crystal.

We have in this case supposed the light passing through the crystal to consist wholly of parallel rays. If instead of these we use a pencil of very divergent rays, a new and very beautiful set of colours and rings are produced. To produce these we must get a plate of crystal cut perpendicular to its axis, if it is uniaxal; or perpendicular to the plane containing the optic axes, if it is a biaxal crystal. The plate should be placed on the stage KH, and a lens of short focal distance under it to receive the light coming from Z. Or if the crystal is small, a little arrangement used by Sir John Herschel, and described in "The Philosophical Transactions" for 1820, may be employed. A B (fig. 6) is a lens on which light falls in parallel rays, and converges to the point *t*. AB is mounted at end of a brass tube ACDB: in this tube fits closely a smaller piece of tube carrying the small plate of tourmaline *t*. This can be turned round through an angle of some 120° by

means of the handle, and which projects through a slit extending some way round the outer tube; C is the crystal to be examined, which may be fixed in the centre of a disc of metal, or between two very thin glass plates; t' is another plate of tourmaline fixed in the cap CD, which can be revolved so as to bring the axis of the tourmaline into any desired position. The colours and curves produced by the crystal are thrown on a screen, placed in front of CD: AB may be about 1 in. diameter. The plates of tourmaline are cut parallel to their axis. Tourmaline is a uniaxal crystal possessing the property of very rapidly absorbing the ordinary ray. A very thin plate will absorb all the light in the ordinary ray, and allow the other only to pass, furnishing a ray polarized in one plane. Plates cut and polished can be readily obtained of the optical instrument makers.

Nitre and arragonite among biaxal crystals, and Iceland spar, some varieties of uniaxal apophylite among uniaxal crystals, produce the coloured curves spoken of very well.

The appearances produced with a uniaxal crystal as the analyzer is turned round are:—In one position we have beautifully coloured circular rings, divided by a black cross. The black cross becomes white, and the colours of the rings are changed to the complementary colours on revolving the analyzer through half a circle. With biaxal crystals the coloured rings are much the shape of the rings seen on a wooden table when the wood is cut across where two knots are close together. These rings are traversed by two dark hyperbolic brushes.*

Another apparatus for producing polarized light, known as Nicols' prisms, is very convenient for certain purposes. Two prisms cut from Iceland spar, of the same angle, are cemented together with Canada balsam, and mounted in corks fitting short brass tubes. The edge of one prism is parallel and of the other perpendicular to the axis of the crystal. Of the two rays into which a ray entering such a combination is divided, one is refracted by the first prism, so that on reaching the boundary it is internally reflected and lost on the blackened surface of the rhombohedron formed by the two prisms. The other ray is refracted, so that it passes both prisms and comes out in a direction parallel to that in which it entered the first prism. The emergent ray is, of course, plane polarized. Two Nicols' prisms form convenient polarizers for the microscope. The one serving as analyzer may be fitted directly above the object glass, and as near to it as possible. It may screw into the tube containing the object glass, or on to the extremity of the erector.

* For good figures of these curves see Pouillet-Müller "Lehrbuch der Physik und Meteorologie," vol. i.

The other prism must fit under the stage. If a concave reflecting mirror, and no condenser is employed, the prism should be as close under the slide as possible. If an achromatic condenser and plane mirror are used, the lower prism should be between the condenser and the mirror. This prism must be capable of rotation round its axis.

We may, as polarizer, instead of a Nicols' prism, employ a glass plate, blackened behind and fixed at the back of the silvered mirror; or a bundle of glass plates. If this arrangement is adopted, a mark should be made, so that the reflector can at once be fixed at the polarizing angle. The plane of the reflecting plate should make an angle of $33\frac{1}{4}°$ with the optic axis of microscope, and then the inclination of the whole instrument, or the position of the lamp, can be altered until the object on the slide is properly illuminated.

If the last plan is adopted, the analyzing prism must be in the eyepiece, so that it can be conveniently turned round on its axis. Each of these plans possesses certain advantages. Completely to examine a small crystal, it is necessary to have the means of rotating both the analyzing and polarizing apparatus. To do this two Nicols' prisms may be used, one fitted over the eyepiece, the other under the stage. The objection to a prism over the eyepiece is, that it limits the field of view, but at the same time it does not cut off much light. Another plan is to have a plate of tourmaline mounted in a piece of tube that will fit the mounting of the eyepiece, and replace its ordinary cap. Tourmaline, however, has the disadvantage of not being colourless as is Iceland spar. Herapathite, so called from its discoverer, Dr. Bird Herapath, is a better polarizing medium than tourmaline. Much thinner laminæ may be employed, and these give no colour to the object. It is difficult to obtain large crystals of herapathite.

In examining those substances by polarized light under the microscope, which do not of themselves produce colour, it is necessary to place a plate of some doubly refracting crystal over or under the object. Silenite is the best. Plates of silenite may be mounted in a brass ring, fitting a circular aperture in a plate of brass made like an ordinary glass slide. The ring should be capable of removal, and of revolving in the brass plate by means of a tangent screw. It is easy to select a plate of selenite which will give good colours. Place an ordinary microscope slide on a piece of black paper on a table in front of a lamp, the distance of the slide from the lamp being half as great again as the height of the lamp. Then split off a lamina with a thin-bladed knife from the crystal of selenite, and hold it between the prism and the glass, the prism being held in such a position that the glass slide appears black. Turn the selenite

until it appears brightest, and then turn round the prism to examine the different colours given by selenite. The brightest colours to be obtained are either a rose-pink and green, or sky-blue and gold-yellow. In a specimen I measured, I found the brightest blues and yellows to be obtained with a plate of thickness about 0·0030 inch, and the best green and pink with a thickness 0·0068 inch. By taking three plates, two of these thicknesses and one of thickness between the two, and combining them in any way by using two or more at once, a great variety of shades may be produced. In using a selenite plate for examining objects under the microscope, it must be borne in mind that the brightest colours are to be obtained only in two positions of the selenite relatively to the fixed polarizer. Therefore if the polarizer and analyzer do not both revolve, care must be taken to mount the selenite, so that on being laid on the slide, it must be in the position relatively to the fixed polarizer to give the best light. This is easily done by trial. First adjust the movable polarizer until the field is black, then introduce the selenite, and turn it round until it is at its brightest. Fix it in this position. A plate of selenite is also useful in examining doubly refractive crystals, when polarizer and analyzer do not both revolve. The most beautiful results are to be obtained with the greatest ease with the polarizing apparatus and microscope.

Drop on a slide a drop of a solution of any salt crystallising in any form not of the cubical system. Then either heat the slide gently over a flame, or allow the salt to crystallise at ordinary temperatures. Groups of crystals of all varieties of patterns will be formed on the slide, and when viewed by polarized light will, if they are of the proper thickness, be invested with the most brilliant hues. With any particular salt, a few trials will soon show the best plan of proceeding. First evaporate the drop rapidly. Examine it, and see if it is the thicker or the thinner crystals, the larger or the smaller ones that give the best colours. If the small thin crystals give the colours best, put a drop of water on the slide rather larger than the drop of solution before used; hold the slide a little sloping, and heat it over a flame. If larger crystals are best, make a saturated solution, and put a thick drop on the slide, and allow it to evaporate slowly. Another plan is to place on the drop of solution a warm thin glass plate. The crystals are then sometimes flat, and the slide may be preserved by running a little gold size round. A slide can also be preserved by castor oil. A little is placed over the crystals and gently heated. A thin glass circle is then placed on and pressed down. This is, in the usual way, secured with marine glue. A long list of substances viewed with advantage by polarized light is given at the end of Dr. Carpenter's ex-

cellent "Microscope and its Revelations." We select a few of the salts mentioned there:—Arseniate of potassa, chlorate of soda, chlorate of potassa, bichloride of mercury, citric acid, chloride of cobalt, chromate of potassa, bichromate of potassa, borate of soda, nitrate of soda, oxalate of ammonia, oxalic acid, sulphate of soda, sulphate of potassa, sulphate of copper ammoniated, tartrate of potassa.

Great advantage is gained sometimes by examining transparent, vegetable, and animal objects by polarized light, the result being to give the effect of perspective by rendering the thicker portions of the substance bright.

Space does not allow of more than a reference to another set of beautiful experiments to be made with the polariscope. Glass under pressure or strain, directly applied, or indirectly by heating and rapidly cooling, or by partially heating, possesses the power of double refraction, and beautiful fringes of interference are seen on looking at it in a polarizing apparatus. For an account of these experiments we refer to the works of Sir J. Herschel, before referred to.

Plate XVII

FREE NEMATOIDS.

By H. CHARLTON BASTIAN, M.D., F.L.S.

THE word "Nematoid" is one, perhaps, not very familiar to general readers; but no suitable popular equivalent can be substituted. When it is stated that one of the most numerously represented groups of the great assemblage of animals known as ENTOZOA has received this name, and that the animals of this particular Nematoid group have been usually known as "round worms," owing to their elongated, cylindrical, or more or less spindle-shaped form, readers to whom the name is unfamiliar will be approximating towards a comprehension of the nature of the animals, whose structure and life-history are to be the subject of this paper. But they will be approximating only, for the animals concerning which I am to treat are not *Parasitic*, but *Free* Nematoids.

The parasitic division of the Nematoid group includes such formidable and well-known human parasites as the now celebrated "Trichina," the Dracunculus or Guinea-worm, also an animal which produces the disease known as "Egyptian chlorosis," and the common round worm, or *Ascaris lumbricoides*—besides a host of others of more or less note, infesting animals of all kinds, even those as low in the scale as Medusæ. And this constitutes one of the most interesting facts concerning the order *Nematoidea*, that it is made up in part of parasites, and in part of representatives, even more numerous still, which are never parasites at any period of their life, but which lead a "free" existence in the most various external habitats. Our knowledge concerning these latter animals is almost entirely of recent date, only a very few representatives of this subdivision having been imperfectly known for a century and a half or two centuries.

Notwithstanding the fact that they have been so much overlooked, in this country especially, the free Nematoids or ANGUILLULIDÆ constitute one of the most widely diffused groups of animals, the representatives of which are met with in the most various natural habitats. So remarkable are they in

this respect, that they seem to vie with the almost ubiquitous Diatomaceæ, with which they are often found associated. Elsewhere* I have thus enumerated some of the situations in which they are to be met with: "Beginning with the land and freshwater species, I have found them in all the specimens of soil examined, in moss, in various species of lichen, about the roots of fungi, also in the roots of grasses and between the sheaths of their leaves, amongst the mud of ponds and rivers, on the freshwater Algæ, amidst decaying liverworts and mosses, and on submerged aquatic plants. The marine species exist in great abundance in the surface mud of rivers and estuaries,† in the sand and amongst the small stony débris under the shelter of rocks, as well as in the tide pools, where they swarm about the roots of the corallines and on some of the smaller and finer sea-weeds, especially those having a dingy appearance from the presence of Diatomaceæ. And lastly, two or three species I have found as pseudo-parasites, within the substance of some of the softer sponges."

These animals, so far as I have seen, have varied in size between $\frac{1}{70}$ of an inch and $\frac{3}{4}$ of an inch in length, though some of the marine forms only have attained the latter dimensions. The largest freshwater species, *Dorylaimus stagnalis*, is about one-third of an inch long. They are all remarkable for the glass-like transparency of their integuments, so that their internal anatomy can be easily ascertained by microscopical examination.

Although much difference exists with regard to the activity of different species—some being slow and tardy in their movements, whilst others are notably the reverse—still the mode of locomotion is very similar in all. This is mostly effected by eel-like undulations of the body, such as at once distinguish these animals from the *Naïdiniæ*, and from Annelids generally. At other times they glide and twine, serpent-like, amongst the branches of the aquatic plants or algæ which they frequent, and occasionally they anchor themselves firmly by means of a caudal-sucker with which very many are provided, and continue for some minutes swaying about in all directions, or darting their bodies hither and thither with the greatest rapidity.‡

* Monograph on the *Anguillulidæ or Free Nematoids, Marine, Land, and Freshwater*, with descriptions of 100 New Species. Trans. of Linn. Soc. (1865), vol. xxv.

† I have found six different species existing more or less abundantly in a small portion of mud that could be held on a shilling piece.

‡ The best method of detecting and capturing these animals is given at p. 92 of my Memoir in the Trans. of Linn. Soc.

The discovery of so many free Nematoids is likely to suggest to many the possibility that these may after all represent only certain stages in the life-history of parasitic forms hitherto unknown, and may cause the belief that the former have no claim to be considered as distinct and independent species. Latterly, however, through the researches of Professor Leuckart more especially, the complete history of many of the parasitic species has been revealed; and though the suspicion has been confirmed that certain stages of the life of many of these are passed whilst they are in a free condition in external media, it has also been shown that, with one remarkable exception, to which I shall again allude, all of them when thus "free" are in an undeveloped, asexual condition. For this reason, although it is perfectly true that many of the parasitic forms lead a temporary free existence at certain stages of their history, it is no less true that there are other Nematoids which are always "free," which pass their whole cycle of existence in external media, and which never become parasites at all. Such are the animals of which I am now writing. These are the real Free Nematoids, whose title to an independent existence is based upon the following considerations. In their various habitats, individuals of all ages may be seen from the young, immature, and non-sexual embryo just emerged from its egg or its parent, up to others in the adult condition; and frequently the ova of species infesting a particular sea-weed may be seen attached to the branches amongst which the parent worms are gliding. This fact alone might induce one to believe that these animals are never parasitic—seeing that they may be observed at all stages of development in their external habitats—even if no other evidence were forthcoming. But I have shown,* also, that they do possess almost invariably certain anatomical combinations which are very rarely encountered amongst the parasitic forms; and that, in addition, some of their anatomical and physiological peculiarities, which are perfectly in harmony with a non-parasitic existence, would be useless or defective were they destined to live within other animals. Thus, many of the free Nematoids, more especially of the marine species, are provided with such rudimentary sense organs as would be useless to a parasite. They consist of ocelli or rudimentary visual organs, in the form of reddish or crimson circumscribed masses of pigment, in which are situated, occasionally, transparent refractive lens-like bodies. These when present are found on the anterior part of the œsophagus (figs. 6 and 7*e*). Almost all the free Nematoids also are furnished with a terminal caudal sucker—most highly developed in the marine species—and to these its utility

* *Loc. cit.* p. 76.

is obvious, since it enables their smooth and polished bodies to adhere to the particular weeds on which they are found, whilst these are swayed to and fro by the currents of the tide, or by the breaking of the waves over the rock pools. Then, again, there is a marked difference in the number of ova or young produced: whilst the parasitic species are most prolific, furnishing offspring by hundreds, thousands, or even millions, and the ova are minute, in the free Nematoids the ova are relatively very large and few in number, being easily countable, and when mature in some species they occupy almost the whole width of the body. This is a state of things quite in harmony with the totally different conditions of life of the respective animals. The free Nematoids produce their ova or young at once in that environment which they are destined to inhabit, whereas the parasitic offspring are subjected to the influence of a multiplicity of chances and adverse agencies, before they can meet with the conditions suitable for their development: this necessarily entails much waste.

Adopting a name which was first given to these animals by MM. Gervais and Van Beneden, the family ANGUILLULIDÆ is now known to include about 180 species, of which more than 100 have been found in this country, and I feel confident that if a diligent search were made in the British Isles by a few zealous observers, the number of species belonging to our fauna might be doubled, or even quadrupled, within the course of a very few years. This may sound like over-sanguine prognostication, but I have an adequate foundation for the belief, based upon my own experiences in the search after these animals, and the abundance of specific forms met with in a few localities only. With regard to the past history of the group I may say that Dujardin discovered several new species, and was the first to give anything like an accurate description of some of these animals. Eberth has, within the last few years, described many new species found on the Italian sea-coast. Schneider of Berlin has also described many new forms, and our countryman Carter has added ten new species to the list, these having been discovered by him in Bombay.* Other workers in this field who have contributed single or smaller numbers of species are Borellus, Baker, Spallanzani, Needham, Otto Müller, Bory, Steinbuch, Dugès, Ehrenberg and Hemprich, Nordmann, Dujardin, Oken, Quatrefages, Grube, Leuckart, Diesing, Max Schultze, Leidy, Kühn, and Cobbold. The first animal of this family that was discovered, happened to be the so-called

* Ann. and Mag. of Nat. Hist. Third Series. July, 1859. In addition to the habitats I have mentioned, I may state that Carter has found some of these animals very abundantly in the substance of large fungi.

"Vinegar Eel," which was met with by Borellus in 1656; and curiously enough the next two chanced to be the "Paste Eel" and the *Vibrio tritici*; and these three, which have been comparatively familiar to amateur microscopists ever since, remained the only representatives of the family known in this country until within quite a recent period.

The zoological characters of the family are as follows:—

FAMILY ANGUILLULIDÆ (GERVAIS AND VAN BENEDEN).

Free Nematoids.—*Body* cylindrical, tapering more or less at either extremity. *Integument* (*a*) transparent, striated or plain, naked or provided with papillæ or setæ (*a'*); often traversed by capillary pores (*a''*); shed and renewed at intervals. *Caudal sucker* (*b*) mostly present. *Glandular system* well developed; often single excretory organ (*c*) in anterior part of ventral region. *Lateral lines* existing as cellular canals (*d*) communicating with the exterior, with or without a central channel; in others replaced by distinct vessels (*d'*). *Median lines* indistinct. *Nervous system* in the form of a ganglionated ring, embracing the anterior part of œsophagus. *Ocelli* (*e*), when present, aggregations of reddish pigment on anterior part of œsophagus, with or without transparent lens-like bodies. *Alimentary organs*: *buccal cavity* present or absent; *œsophagus* (*g*) simple or terminating in bulb-like dilatation, separated by constriction from simple cylindrical *intestine* (*h*), which is enveloped in a layer of hepatic cells. *Generative Organs*: *female*, composed of double symmetrical uteri (*k*), and short reflexed ovarian tubes (*l*), with vagina (*m*) near centre of body, but occasionally this more posterior and then posterior uterine segment and ovary undeveloped; ova (*n*) few, large; oviparous or viviparous: *male*, consisting of an almost simple seminal tube (*o*), and two equal horny spicules (*p*), either alone or with one or more accessory pieces.

In this place I will not enter more fully into the anatomy* of these animals, but will pass on to subjects of more general interest in connection with their physiology and life history.

The free Nematoids are mostly vegetable feeders. They seem to take small quantities of food at a time, consisting principally of portions of smaller algæ, or of Diatomaceæ. The females bring forth their young at all seasons of the year, even in mid-winter. Whether they produce more than one brood seems doubtful, although many of them live for six or eight months at least. Their power of repairing injuries seems very slight, no attempts at repair even seem to be made when their bodies have been accidentally divided, although the separated portions

* Elsewhere I have fully discussed this part of my subject, in a memoir "On the Anatomy and Physiology of the Nematoids, Parasitic and Free, with observations on their Zoological Position and Affinities to the Echinoderms." Phil. Trans. 1866.

continue to move about for more than a week after such an occurrence. The tenacity of life of some of the species is most remarkable, and the young of the so-called *Vibrio*, or as I shall term it, *Tylenchus tritici*, afford the best known instance of this. But before speaking more in detail on this subject I am anxious to correct a very common misapprehension concerning the nature of the disease produced by this animal in wheat.

This disease is generally very local, though persistent also in certain localities; it is known to farmers under the name of "Purples," "Pepper Corn," or "Ear Cockle." Not to speak of the various accounts that have been given of the animal causing it —which has been described as an "infusorial animalcule," and a "curious insect"—it has been, and I believe still is, commonly believed that the hard purple or blackish bodies in which the animals are contained are the diseased seed of the wheat-ear. But Davaine * has conclusively shown that the diseased product is not the altered seed, but is rather a species of "gall" or overgrowth of natural tissue, produced by irritation, owing to the presence of the Nematoid—that it is, in fact, a production in every way analogous to the ordinary oak-gall. Roffredi † and Bauer ‡ were the only ones amongst the earlier observers who attempted to explain the precise way in which the young animals reached the ear: they both were of opinion that the young Nematoids obtained an entry into the vessels of the plant, whence they were carried onwards by the sap and so transmitted to the germen; and in the opinion of this latter observer, the young animals found in this situation were the products of a second generation, whose parents had been produced by the original perforators within the vessels of the plant.

According to the very accurate observations of Davaine, however, which I am myself able to substantiate in great part, the method of production and nature of the disease is as follows When infected galls are sown with healthy seeds (or seeds are planted having young animals placed within their clefts), the young, in a week or so, according to the degree of moisture of the soil, make their way out of the softened gall, and, diffusing themselves in all directions, some come at last into contact with the budding plant just sprouting from the healthy seed. They then insinuate themselves between the sheaths of its leaves, gradually working their way around till they come to the innermost of these. Here they remain for a variable time, without increasing much in size, till the rudiments of the future

* In an admirable memoir, entitled "Recherches sur l'Anguillule du Blé Niellé," Paris, 1857.

† Observ. sur la Physique, t. v. p. 1, 1775.

‡ Philos. Trans. 1823.

ear begin to form. The length of time during which they remain in this situation, and their degree of activity, depend upon the rapidity of growth of the plant and the moisture of the season. It is well known that the rudiments of the ear are formed early, though this remains for a long time enclosed between the sheaths of the leaves before it makes its appearance externally; and in order that this disease of the wheat may be produced, it is necessary that the young Nematoids should come into contact with the ear at a very early stage of its development, when the paleæ, the stamens, and the ovary exist only as soft cellular scales, scarcely separated from one another. Whilst in this soft, almost pulpy condition, the several parts of the flower are easily penetrated by the young Nematoids, which would be quite unable to obtain an entry should they come into contact with the ear at a later stage of its development, when the several parts of the flower have become quite distinct from one another, and their tissue consolidated. This piercing and occupation of a part of the rudimentary flower arrests its development, though it stimulates growth. A galllike body is more rapidly produced in the site which should have been occupied by the germen, whilst the young worms soon become perfectly developed males and females. These vary in number from two to ten, or even twelve, in each gall, and in the course of time the females produce an enormous number of ova, each containing an embryo Nematoid coiled within, which soon liberates itself by bursting its membranous egg-shell, though it afterwards undergoes little change within the germen. The parent animals die, and their bodies shrivel, at the time when the gall begins to assume its characteristic purplish-brown or black appearance. When burst open, after soaking in water, it is found to contain myriads of the young animals with remains of their membranous envelopes, together with the withered dead bodies of the parent Nematoids. In evidence that the animals are not contained within an altered seed, as formerly supposed, I may state that Davaine has occasionally found a small abortive germen within the same floral envelopes with the gall, and in this case the gall has in all probability had its origin in one of the rudimentary scales which would have gone to form a stamen. He believes it may be formed out of any of the scales belonging to the central parts of the flower; and although, as a rule, all these parts participate in the formation of a single central, still occasionally as many as three growths of this kind develop within the same pair of *paleæ*. On one occasion he found a growth of a similar nature and with the same kind of contents, growing from one of the leaves of the wheat. After this, additional proof as to the nature of the growth is almost superfluous. I may however add, that

in my own experiments, I have found that when these galls had attained their full size and maturity between the altered glumes and *paleæ*, other healthy plants, growing by the side of the diseased one, were only just flowering, and their germens were still minute and undeveloped.*

In harmony with this method of infection of the wheat by *Tylenchus* (*Vibrio*) *tritici*, I have found in several grasses different species of these free Nematoids lying between the inner sheaths of the leaves near the bottom of the culm. In *Festuca elatior* I met with no less than five species in this situation belonging to the genera *Dorylamius*, *Mononchus*, and *Plectus*; and in the stalks of wheat and oats removed from stubble-fields I have frequently found specimens either of these genera or of *Rhabditis*, *Aphelenchus*, or *Cephalobus*. In addition to a malady of oats and maize similar to that of wheat, and said to be produced by the same animal, Steinbuch,† nearly a century ago, recognised a disease somewhat similar to "purples" in two of the bent-grasses (*Agrostis*); and from the frequent presence of free Nematoids in the situation named, I suspect such diseases of grass would be found more frequent if specially looked after. As another instance of disease induced in plants by these animals, may be mentioned the discovery of Kühn‡—who has ascertained that a long-known disease of the common teasel (*Dipsacus fullonum*) is owing to the presence of a multitude of minute Nematoids, giving some parts of the flower a white filamentous appearance. These animals are endowed with the same tenacity of life as *Tylenchus tritici*, and for anatomical reasons evidently belong to the same genus.

Turning now from this digression concerning the remarkable disease in wheat which has just been described, let us consider the question of the tenacity of life of the individuals causing it, and of the free Nematoids generally. In the first place, let me state that the power of resisting long periods of desiccation, which is known to be possessed by the young of *Tylenchus tritici*, is by no means possessed by all the free Nematoids, although this has been more or less explicitly affirmed by several writers. As a rule, the free Nematoids are frail and delicate, and do not recover even after a slight desiccation of five or six minutes, though the case is very different with members of the four land and fresh-water genera *Tylenchus*, *Plectus*, *Aphelenchus*, and *Cephalobus*: with all these there is a remarkable tenacity of life and power of recovery after complete desiccation.

* For the best means of dealing with this disease of wheat when prevalent, and for other details, I must refer to M. Davaine's admirable essay.

† Naturforsch. xxviii. S. 233, Tab. v.

‡ Zeitsch. für wissen Zoolog. 1857, t. ix. p. 189.

I have found no representatives of these particular types in salt water; and, as far as my experience goes, the marine species are all incapable of being revived after having remained without water on a slip of glass for a few minutes.

I have been able to verify the observations of Spallanzani, Dujardin, and others, regarding the tenacity of life evinced by the Nematoids found in tufts of moss. These animals do not, however, belong to the genus *Rhabditis*, as reported by Dujardin; they are distinct types which I have included under the genera *Plectus* and *Aphelenchus*. Similar forms are met with in many of our lichens, and notably so in the fine orange-coloured *Parmelia parietina*, from old houses and walls. In both lichen and moss the Nematoids are, as first observed by Spallanzani, almost invariably associated with certain *Rotifera*, and curious slow-moving arachnidal animals, called by him "sloths." These three different types of animals all possess the same kind of tenacity of life. Very many of the species of the four genera of Nematoids I have mentioned are found in earth, lichen, moss, or other situations in which they are exposed to constant vicissitudes of drought and moisture, according to ever-changing meteorological conditions, and in the possession of this power of resisting the effects of desiccation, they are endowed with the only means of neutralising what would otherwise be the fatal influence of the varying conditions of their environment. The life-history of these species must be a strange one, made up of periods of life and activity alternating with others of apparent death—the two states bearing no definite relation to one another as regards duration, being altogether inconstant and variable, and succeeding one another under the influence of laws so remote as to make their successions of active and passive existence seem almost a matter of chance. Doubtless they have a *definite span of active existence* in which to go through their stages of growth, development, and reproduction. But whilst the sum-total of these periods of active life peculiar to the species may be pretty definite, the duration of time over which their fragmentary existence may be extended, is altogether variable and indefinite, owing to the uncertain length and number of the interpolated periods of apparent death. An admirable exemplification of this is seen in *Tylenchus tritici*; the duration of the *active* life of this species is probably about nine or ten months, but individuals have been known to retain their life for a period of twenty-seven years. Thus, Baker ascertained that some of the animals contained in diseased wheat, given to him by Needham in 1744, still possessed the power of resuming all their vital manifestations in 1771, after immersion for a time in water.

Davaine has made a most elaborate series of experiments upon

the *reviviscence* of the young of *Tylenchus tritici*. To ascertain the effect of different degrees of desiccation, young *Tylenchi*, three years old, were taken and placed under the receiver of an air pump, together with a large capsule containing concentrated sulphuric acid, to absorb all aqueous vapour; the air was then exhausted, and the animals allowed to remain *in vacuo* for five days. When withdrawn and immersed in pure water, most of them resumed their activity after a period of three hours. Subsequent experiments convinced him that larvæ varying from one to three years old, invariably recovered as quickly after they had been completely desiccated by a sojourn of five days in a vacuum, as did others of the same age which had merely been exposed to the air for a similar period. Davaine found these animals irreclaimably lost their vitality when submitted to a dry heat of 160° F., though their power of resisting low temperatures was most remarkable: they recovered all their vital manifestations after having been subjected to the intense cold of 0° F. for eight or ten hours.

The experiments which have been conducted by MM. Doyère and Gavarret* upon the degree of tenacity of life possessed by the Rotiferæ, "Sloths," and Anguillulidæ found in tufts of moss are of the most interesting description, and were conducted with the greatest care and caution. Some of the startling results at which they arrived may be appreciated by the brief narration of one experiment destined to test the power of resisting simple desiccation at ordinary temperatures possessed by these animals. *Portions of moss which had remained sixty-seven days in a cabinet, were submitted for two days to the influence of dry air, and during fifty-one days to the action of a vacuum. The mosses then became so completely dried that, after four days of exposure to the double influence of a vacuum and sulphuric acid, they underwent not the slightest diminution in weight, and yet, after twenty-four hours of simple moistening with water, the rotifers, the "sloths," and the Nematoids had completely regained their activity.* Unfortunately, other interesting results arrived at concerning the influence of heat upon previously-desiccated animals, refer to the two former varieties only, since no Nematoids, either living or dead, were seen in these later experiments. The Rotifers and "Sloths," however, recovered after having been submitted for a few moments to a dry heat of more than 212° F.

It was first observed by Spallanzani that one of the essential conditions for the revival of these animals found in tufts of moss was, that their period of desiccation should either be passed in the tufts, or else that during this time, their bodies

* Ann. des Sc. Nat. 4me Sér. t. xi. 1859, p. 319.

should be more or less covered with sand. His explanation of this fact was, that the access of air exercised a prejudicial influence upon the delicate tissues of these animals. The fact is quite in accordance with my own observations; and, as regards explanation, I am able to offer none more satisfactory than that advanced by Spallanzani. From numerous experiments, I have ascertained that the power of recovery after desiccation, possessed by the Nematoids found in moss and lichen, is most wonderfully curtailed if animals singly are placed upon a clean slip of glass, and allowed to become dry when thus freely exposed to the air. For instance, as a rule, these same Nematoids of moss and lichen, which showed such a marvellous tenacity of life in the experiments of Doyère and Gavarret, rarely recovered at all after an exposure of forty-eight or even thirty-six hours on a glass slip. So far as I have seen, young specimens are certainly not capable of resisting exposure better than or even as well as adults, although the reverse is notably the case with *Tylenchus tritici*. But with animals belonging to the genera *Chromadora*, *Enoplus*, *Monhystera*, *Leptosomatum*, *Mononchus*, *Dorylaimus*, and many others, the results have been very different and almost uniform. I have never succeeded in restoring any of these animals after they have remained dry and motionless on glass for two minutes; many would not recover after one minute of such exposure, and with *Chromadora communis*, one of the most abundantly represented species of our tide pools, I have rarely been able to revive specimens after even half a minute's exposure, dating from the time of the *cessation of movement in the drying animal*, as seen under the microscope.

It seems to me that the increased tenacity of life exhibited by the members of the four genera *Tylenchus*, *Aphelenchus*, *Plectus* and *Cephalobus*, is *partly* connected with the power they possess of retaining their tissues in a moist condition for a longer time than the others, owing to the comparative or even total absence in them of the integumental pores which appear to be present in most of the other species of free Nematoids. The fact that such pores cannot be discovered in any of the members of these genera is pretty certain, and these differ from other free Nematoids also by the possession of peculiar lateral vessels, and a modified structure of the ventral excretory gland, whose duct seems very much narrower and more rigid, than when it occurs in species which have not the same tenacity of life (figs. 5 and 7).

Before concluding these remarks on the Free Nematoids, I would point out that although, in a zoological sense, these animals are to be considered as quite distinct from the parasitic Nematoids, still we see, on examining more closely, certain

transition forms which tend to break down the artificial barriers between these two groups of the order *Nematoidea*. As before stated, many of the free Nematoids live for the most part as parasites upon plants; and two or three of the most highly organized and typical species—animals provided with the most distinct ocelli—habitually live as pseudo-parasites within the substance of some of the softer marine *Spongiadæ*. Although the animal nature of sponges is undoubted, still these differ so much from the higher animals that Nematoids existing within them are subjected to conditions very slightly differing from what they would have experienced amidst the corallines found in the same tide pools; and consequently, even the same or most nearly allied species may be met with indifferently in either habitat. Elsewhere, too, I have shown* there are strong grounds for believing that the Guinea-worm, so well known as a human parasite, is a parasite only accidentally, and that it and its parents were originally free Nematoids. So that we have free Nematoids, so to speak, parasitic upon plants; others parasitic upon lower animal organisms, such as the *Spongiadæ*; and one even accidentally parasitic upon man himself, in the case of the Guinea-worm. But, most marvellous of all, we now know of an animal which in succeeding generations leads alternately the life of a free and of a parasitic Nematoid. This animal is *Ascaris nigrovenosa*, which has long been known in its parasitic condition as it exists within the lung chambers of the frog. But it has been shown by Leuckart and Mecznikow that the young of this animal become real free Nematoids, for, after passing from the intestine of the frog into damp earth or mud, they grow rapidly, and actually develope in the course of a few days, whilst still in this external medium, into sexually mature animals. Young, differing somewhat in external characters from their parents, are soon produced by them, and these attain merely a certain stage of development whilst in the moist earth, arriving at sexual maturity only after they have become parasites and are ensconced in the lung of the frog. This is a most marvellous life-history. Such a regular alternation between the parasitic and the non-parasitic state by succeeding generations, each produced from ova, exhibits an instance unparalleled, so far as our present knowledge goes, throughout the whole animal kingdom.†

* On the Structure and Nature of the Dracunculus, or Guinea-worm. Trans. of Linn. Soc. vol. xxiv., p. 130, also Phil. Trans. 1866, p. 609.

† The history of this animal will be more marvellous still, if Professor Leuckart's supposition be correct (and it seems the most probable one), that the young of the parasitic forms are produced by a process of *agamogenesis*. No parasitic males of this species have ever yet been met with. The same mode of generation seems to exist in the parasitic Guinea-worm, as I have

Thus we see another instance of the fact that the artificial barriers which zoologists establish between different groups of animals, are after all purely conventional, and to be taken only in a broad sense. Examined more closely, we see that, however convenient and necessary such classifications may be for facilitating our knowledge of the animal kingdom, no such barriers and strict demarcations exist in Nature—differences are gradually smoothed down and resemblances increase between animals of different zoological families which may widely differ from one another in their extreme types.

EXPLANATION OF PLATE.*

FIG. 1. *Dorylaimus Stagnalis*, Dujard. Female, × 20.
" 2. Ditto Male, × 20.
" 3. Anterior extremity of same, more highly magnified, showing exsertile spear, with reserve spear in substance of œsophagus, × 150.
" 4. Posterior branch of uterus and ovary of *Plectus parietinus*, Bast., showing single file of large ova in latter, × 300.
" 5. Anterior extremity of *Tylenchus tritici*, Bast., × 150.
" 6. Anterior extremity of *Leptosomatum figuratum*, Bast., × 60.
" 7. Anterior extremity of female *Phanoderma Cocksi*, Bast., × 75.
" 8. Posterior extremity of same, × 75.
" 9. Posterior extremity of male *Phanoderma Cocksi*, × 75.

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elsewhere shown, and the male parasite of this species also has never been met with. Indeed, the life-history of this species, when fully ascertained, will probably approach very closely to that of *Ascaris nigrovenosa*; but at present the Guinea-worm is unknown in its free condition. And instead of a regular and necessary alternation existing between the free and parasitic states of this animal, it would seem more probable that such alternation only occurs occasionally as an accidental and extraordinary occurrence in the life-history of certain individuals.

* For explanation of letters of reference to figures see Family Description, p. 167.

REVIEWS.

ARTIFICIAL SELECTION AND PANGENESIS.*

THE narrow limits of our space make us dread so serious an undertaking as the review of the two wonderfully comprehensive volumes which Mr. Darwin has just laid before English naturalists. The vast accumulation of facts displayed, the complex and intricate thread of induction pursued, and the numerous aspects in which the whole subject is exposed by the author of the "Origin of Species," cause us to approach even an outlinear sketch of the work before us with no little diffidence. Our readers, therefore, will understand that it is from no want of appreciation of the importance of the problem that we refrain from a more lengthy discussion of Mr. Darwin's masterpiece of scientific essayism. Indeed, so difficult do we consider the effort to give a lucid exposition of the latest argument which Mr. Darwin advances, that we regret, for the sake of the theory, that the author was not induced to publish a popular epitome of the facts of his case, and did not address the treatise now before us to the scientific public exclusively. For, after all, it must be confessed that even enthusiastic general readers may quail before nearly 1,000 pages of scientific matter, most of which are in small type, and all of which are, so to speak, crammed with "condensed fact." Nevertheless, we shall try, as clearly as possible, to lay before our readers an elementary notion of what Mr. Darwin tries to prove in the work under notice.

Those who have paid any attention to the question are aware that Mr. Darwin has hitherto confined his argument to the evidences drawn from animals and plants in a natural condition of existence. In the present instance, he brings under notice all the facts he has been able to collect concerning the domestication of animals and plants, and the formation of new breeds by artificial selection. In addition to this branch of the problem, in his second volume he deals with the subsidiary questions of the laws which govern variations and inheritance; and finally he proposes and supports a new hypothesis which has as much intrinsic interest as that of Natural Selection, and which he has termed Pangenesis. The theory and its testimony we may now consider *seriatim*. We must, however, premise that as Mr. Darwin examines the history and anatomy of every breed of domesticated organism, and gives, as it were, a complete monograph on each, we shall limit our remarks to one or two of the following animals: dogs, cats, horses, asses, pigs, cattle, sheep, goats, rabbits, pigeons, fowls, ducks, geese, peacocks,

* "The Variation of Animals and Plants under Domestication." By Charles Darwin, M.A., F.R.S. 2 vols. London: John Murray. 1868.

turkeys, and gold fish. Pigeons and rabbits form, perhaps, the best examples of the immense influence of artificial selection in the production of new organic forms. This is because the selection and breeding of these animals have been made so much of an art and science, and because the history of the several breeds is so well and fully recorded. Taking the group of pigeons, and studying the history of its origin, Mr. Darwin, it seems to us, shows conclusively that the 150 different kinds have all descended from one common progenitor, the *Columba livia*, or rock pigeon. This is a great point to have demonstrated, for it is nothing less than this, that man, by carefully watching the variations of the several generations of pigeons, and selecting for reproduction those which possessed the features required for perpetuation, has succeeded in establishing a number of families of pigeons as different from each other as from the primal parent, as capable of regeneration as any natural species, and exhibiting anatomical peculiarities which, if seen in feral animals, would at once justify the naturalist in regarding such animals as perfectly distinct species. The osteological results of this artificial selection are not so important in pigeons as in other domestic creatures; still, even on this point they are by no means insignificant. For example, we find even the total number of vertebræ—a formidable specific feature—modified; in the rock pigeon, the total number being 39, it is 42 or 43 in the Pouter, whilst in the Dutch Roller it is only 38. The total of observed modifications, as summed up by Mr. Darwin, is as follows:—

"To sum up, we may confidently admit that the length of the sternum and frequently the prominence of its crest, the length of the scapula and furculæ have all been reduced in size, compared with the same parts in the rock pigeon; and I presume that this may be safely attributed to disuse or lessened exercise. The wings, as measured from the ends of the radii, have likewise been generally reduced in length; but, owing to the increased growth of the wing-feathers, the wings from tip to tip are commonly longer than in the rock pigeon. The feet as well as the tarsi, conjointly with the middle toe, have likewise in most cases become reduced; and this, it is probable, has been caused by their lessened use; but the existence of some sort of correlation between the feet and the beak is shown more plainly than the effects of disease."

We cannot dwell upon the other points of anatomical difference which the author describes. We must, therefore, pass on to his reasons for believing that all these several varieties have descended from a common stock. These reasons are:—First, the improbability that more than one wild species should still exist somewhere unknown to ornithologists, or that they should have been extinguished within the historical period; secondly, the improbability of man having in former times thoroughly domesticated as many different species as there are breeds at the present day; thirdly, the unlikelihood of man's selecting several abnormal species; fourthly, the fact that all produce mongrels; fifthly, the important fact that all these races, whether crossed or not, occasionally revert—throw back, as breeders say—to a form which more or less closely resembles what Mr. Darwin regards as the ancestral type, the *C. livia*.

Rabbits present us with another remarkable example of the production of divergent forms by the influence of artificial selection. As in the case of

pigeons, Mr. Darwin urges the extreme probability that all the domestic breeds of rabbits have been derived from one ancestor. He then shows what cautious observation is exercised to determine the minute variations and the necessity for careful pairing in order to avoid reversion. On all these particulars his remarks are of the highest interest. But in regard to the alterations in the skeleton, we think the domestic rabbits afford conclusive testimony. The changes in the bones of these animals are of the gravest character. The bones of the limbs have increased in weight in proportion to the weight of the body. With the increased size of the body the third cervical vertebra has assumed characters proper to the fourth cervical; and the eighth and ninth dorsal vertebræ have similarly assumed characters proper to the tenth and posterior vertebræ. The skull in the larger breeds has increased in length. The brain appears to have decreased in size. The supra-orbital processes of the frontal bones and the free end of the malar bones have increased in breadth, and in certain breeds the occipital foramen differs from that of the wild rabbit. In like manner, the scapulæ, the bones of the ear, palate, and jaw, have, by processes of correlation, become highly variable and modified. The facts which we have quoted upon the history of two races will be found multiplied in Mr. Darwin's book for every domestic family of animals and plants; and this part of the subject occupies the greater part of the first volume.

The next points to be inquired into are those of variation, its laws and causes, and inheritance. These are discussed in the author's second volume; and their examination leads him to the remarkable hypothesis—Pangenesis, to which we have already referred. Starting with the proposition that the progeny of all animals displays variation—a proposition which it seems to us impossible to gainsay—the author proceeds to indicate the laws under which this tendency is governed. He thus formulates the following rules with respect to inheritance:—first, a tendency in every character, new and old, to be transmitted by seminal and bud generation, though often counteracted by various known or unknown causes; secondly, reversion or atavism, which depends on transmission and development being distinct powers; it acts in various degrees and manners through both seminal and bud generation; thirdly, prepotency of transmission, which may be confined to one sex or be common to both sexes of the prepotent form; fourthly, transmission limited by sex generally to the same sex in which the inherited character first appeared; fifthly, inheritance at corresponding periods of life, with some tending to the earlier development of the inherited character.

It is rather difficult to determine satisfactorily the opinion of the author on the question of the influences which determine variation in animals, as to whether, for instance, they are the result of what the older metaphysicians would style a "natural tendency," or are the consequence of the influence of external conditions. In one portion of his book he so distinctly opposes the theory of the operation of externals, that we are led to think he is of the metaphysical school. But then, further on, he so fully admits the effects of use and disuse in affecting the inheritance of certain qualities, and he so fairly acknowledges the inheritance of certain mutilations, such as those inflicted on rabbits by Dr. Brown-Séquard, that we are convinced

he objects rather to the extreme arguments of the external-conditionists, if we may so style them, than assumes the existence of so illogical a principle as a natural tendency. On the whole, we are disposed to believe that Mr. Darwin believes that species vary in every generation from the action of external conditions, but that he would employ the expression "external condition" in its widest sense, and would not limit it, as some folk do, to temperature and atmospheric changes. There can, we think, then, be little doubt that Mr. Darwin has demonstrated the following propositions:—1st, that in every group of animals the individuals tend constantly to diverge by variation from the parent type; 2nd, that these variations are in heritable under certain definite laws already expressed; 3rd, that by selecting and breeding from animals with any particular physical quality, that quality may be enhanced through successive generations till it becomes a permanent character; and, 4th, that the differences thus produced are quite as formidable as those on which naturalists base their distinction of feral species. Thus far, and no farther. There come, then, for consideration the questions of Mr. Darwin's opponents, who say, "You have undoubtedly produced new animal forms, which seem worthy of being called species, but for this fact, that *natural* species are sterile *inter se*. *Your* species are perfectly fertile, and if allowed to breed together would produce mongrels, and revert to the parent species. Until you explain this anomaly, we decline to accept your views." This is certainly the most difficult point in the whole controversy, and this is Mr. Darwin's reply to it:—

"Passing over the fact that the amount of external difference between two species is no sure guide to their degree of mutual sterility, so that similar differences in the case of varieties would be no sure guide, we know that with species the cause lies exclusively in differences in their sexual constitution. Now the conditions to which domesticated animals and cultivated plants have been subjected have had no little tendency towards modifying the reproductive system in a manner leading to mutual sterility. But we have good grounds for admitting the directly opposite doctrine of Pallas—namely, that such conditions generally eliminate this tendency; so that the domesticated descendants of species which, in their natural state, would have been in some degree sterile, when crossed become perfectly fertile together. With plants, so far is cultivation from giving a tendency towards mutual sterility, that in several well-authenticated cases already often alluded to, certain species have been affected in a very different manner, for they have become self-impotent, whilst still retaining the faculty of fertilising and being fertilised by distinct species. If the Pallasian doctrine of the diminution of sterility through long-continued domestication be admitted—and it can hardly be rejected—it becomes in the highest degree improbable that similar circumstances should commonly both induce and eliminate the same tendency; though in certain cases, with species having a peculiar constitution, sterility might occasionally be thus induced."

We have already so far transgressed the limits allotted to us, that we have barely space to call attention to Mr. Darwin's theory of ***Pangenesis***. This, which is a modification of Reaumur's and Bonnet's (see Quatrefage's ***Metamorphoses of Man and the Lower Animals***: Hardwicke) Panspermy, may be shortly expressed as follows:—The tissues of the body in both male and female

(plant and animal) are constantly throwing off minute atoms, which, under favourable circumstances, are capable of reproducing the particular tissue from which they were derived. These accumulate in the ovum on the one side and zoosperm on the other, and in the union of these two the elements of the tissues and organs of two individuals combine. Accordingly, therefore, as one or other of these elements predominates, the resultant will resemble either the male or female parent. But it sometimes happens that the two antagonise each other; and, when this occurs, a certain number of the molecules of the early ancestors, which have lain dormant like so many "statoblasts," come into play and produce reversion. Such is, in rough and imperfect outline, the last theory which Mr. Darwin propounds. It is not only fully *en accord* with his theory of natural selection, and with the facts which he advances in support of it, but it requires no extreme elasticity of imagination for its acceptance; and it is so thoroughly in agreement with ordinary physical laws and with the phenomena of development, that we think it is likely to find warm advocates in the biologists of all countries. Ere we conclude, let us offer our hearty thanks to Mr. Darwin for the dignified and truly philosophic manner in which he has conducted his controversy with his opponents. He has done good to those who have despitefully used him, by showing them that he is uninfluenced by the petty feelings which have led them into an indulgence of invective damaging only to their cause. By proving to them that philosophy is beyond vituperation, he has upheld the honour of science, and cast a silent reproach on those who think that credulity and poetic sentiment are higher gifts than reason and observation.

THE STONE AGE.*

SIR JOHN LUBBOCK has done good service to Ethnology in bringing Professor Nilsson's treatise under the notice of the English public. Professor Nilsson, though well known to German Archæologists, and though himself a keen student of British antiquities, has not up to this received the recognition of English students. In the volume before us he has treated of the relics of the men of the Stone Age in Sweden, and he has dealt with his subject in a manner at once so comprehensive and attractive, that his work will be read with as much pleasure and advantage by the professional as by the amateur Archæologist. In order to render the book as useful as possible even to those unconversant with the recent labours of Ethnologists and Geologists, the editor has added an Introduction, which in clearness and force of argument is unsurpassed by anything he has before written. Sir John Lubbock gives a most instructive sketch of the position of prehistoric Ethnology as it stands at present; and as his views embrace the most modern conclusions, we cannot refrain from giving our readers a brief

* "The Primitive Inhabitants of Scandinavia." By Sven Nilsson. Third edition. Edited, with an Introduction, by Sir John Lubbock, Bart., F.R.S London, Longmans. 1868.

summary of this part of the volume. It is a somewhat difficult matter to convince a person fresh to the subject that man has existed upon the earth for hundreds of thousands of years before the Christian era; but we think Sir John Lubbock has grappled with his task in a more than ordinarily satisfactory manner. Adopting the more generally received opinion, he considers that from the time when man first appeared on the globe up to the Historic period, the human race has passed through four distinct phases, which are associated by Archæologists with as many separate epochs. Thus we have (1) the Palæolithic or First Stone Age; (2) the Neolithic or Second Stone Age; (3) the Bronze Age; and (4) the Iron Age. The savages of Palæolithic times seem to have been characterised by a barbarism of the most primitive type. The relics they have left us on which to found their history are found in beds of gravel or loam, technically styled *locss*, which extend along our valleys, and occasionally reach a height of 200 feet above the present water-level. These beds were deposited by the rivers which now flow through Europe, and which ran then in the same direction as now, and drained the same areas as they do in our days. Hence the contour of Europe must have been very much what it is at present. The fauna, however, was of a very different type from the present one, and comprised among other animals the mammoth, the woolly-haired rhinoceros, the hippopotamus, urus, musk-ox, reindeer, &c. It would appear, too, that the climate was extremely cold.

All the remnants left us of the men of those times are a number of rude unpolished implements of stone; no traces of pottery or metals have been discovered. The people who characterised the Neolithic Age seem to have advanced in civilisation over their predecessors, as they were also less remote chronologically. Their remains are never found in the drift-gravels; but are to be met with in those curious shell-heaps known as Kjökkenöddings, and in the ancient lake-dwellings or Pfahlbauten of Switzerland. It is another mark of this age that its relics are not associated with the remains of the Mammoth. They also used weapons of stone, but their handiwork, if so it may be termed, is manifestly an improvement on that of the preceding epoch. The implements they have left us are of stone, but polished, and not rudely "hacked out" of the block, like the Palæolithic weapons. A further advance is shown in the remains of hand-made pottery of a rude description, in the existence of cultivated cereals, of fabrics of woven flax, and of the bones of domestic animals, such as the ox, sheep, goat, pig, and dog. The Neolithic period was followed by an age in which bronze was extensively employed for weapons of warfare and the chase. Some of the bronze axes are exact copies of the rude stone ones, but others show very distinct ornamentation of a particular character. Gold, amber, glass, silver, lead, and zinc, were in use, and some coins also have been discovered; writing, however, appears to have been unknown. The age of iron was the last phase presented by primitive man, prior to the Christian epoch. The relics of the "iron men" are found in large numbers in the lake-village of La Tene, in the Lake of Neufchâtel, and also in the Nydam "find" in Denmark. In these remnants scarcely any flint implements are seen, and only few bronze ones, while the number and quality of the iron implements indicate a very decided improvement in civilisation, and a dawning conception of the art of ornamentation.

Besides stating succinctly the special features which characterise each age, and distinguish one from the other, Sir John Lubbock takes the series of statements made concerning each race, and categorically proves the assertions made by geologists. This part of the work we especially commend to our readers. We shall now pass on to consider the labours of Professor Nilsson.

The author's object is to describe the ancient races of Sweden, and, by a careful examination of the weapons, homes, and habits of existing aborigines, and an analysis of the legendary lore of the Scalds and Sagas, to show that the race which once roamed over Europe was closely allied to if not identical with the Esquimaux. This latter mode of viewing the subject gives an especial attractiveness to Professor Nilsson's work, for it renders the subject as deeply interesting to the Antiquary as to the Geologist. The mass of evidence which the author has advanced proves his case very satisfactorily. The testimony is divided into several sections, of which we shall select those relating to the nomad habitations of the Esquimaux, and the characters of some of the weapons of existing savages. The facts collected by the author show us the exact character of the habitations of the men of the Stone Age in Sweden, and of the modern Esquimaux, and satisfy us that in this respect the two races display an extraordinary analogy. The following remarks by the author put the comparison very neatly:—

"What, therefore, the Esquimaux huts and the tumuli have in common with each other is that they all have flat roofs, that they all contain a chamber about five feet high, and are provided with a long covered side gallery, two or three feet broad, and three feet high, always pointing to the east or south. They resemble each other also in their form, which varies, being sometimes round, and sometimes an oblong square. Their interior arrangement also is in the main the same. In both, the centre of the floor is unoccupied, but the chamber is divided along the walls into cells or stalls, and in these stalls the inmates—of the sepulchres as well as of the dwellings—sit in the same stooping position which all polar people affect. It seems scarcely possible to assume that all these various important and minute similarities should be only accidental." Professor Nilsson does not think them accidental, but he nevertheless declines to assert that the two dwellings are the work of the same people. Further on, in his examination of the ancient crania of Sweden, he corrects an impression which a superficial observer might possibly form. He tells us that the skulls of the Stone Age are all dolichocephalic (long-headed), like those of the modern Esquimaux. It is true that a few brachycephalic skulls have been met with in some of the sepulchres, but they are clearly exceptions. What does this argue? Simply this: another bond of union between the Esquimaux and the Swedish "Iron" men, and also that the ancient Swede had no relation to the modern Laplanders, since the latter are all eminently brachycephalic. The arguments from analogy in the construction of weapons of defence are also extremely convincing. Professor Nilsson urges several, but one is sufficient. Having given a minute description of a species of fish-spear, from North America, which is now in the ethnological department of the Museum of Copenhagen, he goes on to say: "It is remarkable that the half of an implement, evidently similar to

this last mentioned one, has been found in the peat-bog of Felsmosse, about three English miles from Lund in the province of Scania. This bone dart is seven inches long, round, and compressed; the back a little thicker, pointed towards the top end, round and bent outwards a little; the inner side somewhat compressed with five broad incisions, forming teeth bent backwards; the lower end broader and also compressed, the inner edge provided with oblique notches forming teeth pointing forward, which thus prevent the dart being drawn forward. But what still more shows the perfect likeness between the North American and the Scanian instrument is, that if we carefully examine the latter, we shall find it scratched transversely in two places, the one at the place where the strings in the American one attach the points to the shaft, and the other a little way higher up, where the shaft ends in the American implement, and where the points are tied round; the Scanian is in other respects entirely even and smooth." This is striking enough, and is calculated to establish a strong analogy between the two nations, but the sketches the author has given of the two instruments leave no doubt in the reader's mind as to the identity of the races which constructed them. Here we must say a word of praise in favour of the admirable plates appended to the volume, and which are in the highest degree creditable to the Swedish lithographer. *Tout entier*, the "Stone Age" is a book which few who take up will fail to read through with pleasure. The style is clear, the arguments forcible without being exaggerated, the testimony ample, and the mode of treatment startling and fascinating.

FARADAY AS A DISCOVERER.*

IN his usually brilliant and forcible style, Professor Tyndall has given us a biography of Faraday the Philosopher. The reader will perhaps think that the life of the Man should have been rather selected than that of the Discoverer; but those who know anything of Faraday are aware that his love of science was so pure and unalloyed, so thoroughly for the pursuit itself rather than the fame which attached to it, that the history of his work, and of his many efforts to search out Nature's phenomena, is absolutely his whole biography. The book which Messrs. Longmans have issued is the report of lectures delivered before the Institution, but it is enhanced by the addition of two admirable portraits of kind, genial, pensive Faraday, taken at different periods of life, but both faithful records of the face which frequenters of the Institution love to look back on. Dr. Tyndall has traced the gradual progress of Faraday's discoveries and experiments in Physical Science, from the time when he first became the assistant of Sir Humphrey Davy. This account, besides its interest from the associations with the man, has an intrinsic worth which will be highly appreciated by the physicist. The sketch is enriched by numerous letters written by Faraday to Dr. Tyndall and other fellow-workers in

* "Faraday as a Discoverer." By John Tyndall. London: Longmans. 1868.

science, and these more than anything display the pure-minded, simple-souled, wonderfully speculative man, in the truest and most natural colours. They are most touching, and they give to Dr. Tyndall's portrait of Faraday a pre-Raphaelitic character which is striking and impressive. We think this biography should be read by every student of science, no matter to what department he may belong; for the eloquent and pathetic discourse of Professor Tyndall, which, we doubt not, has moved many of his audience to tears, leaves no doubt upon our mind that "Faraday was the greatest experimental philosopher the world has ever seen."

PRECIOUS STONES.*

MR. KING should have given his work a different title. It is really not a natural history of precious stones, but is rather an account of particular precious stones which have become historical. The existing title is calculated to mislead the mineralogical student, who would expect to find in its pages a scientific description of all species of precious minerals, but really meets with nothing more to his purpose than a graphic and extremely interesting history of such stones as the Sancy, Koh-i-noor, and other celebrated jewels. Mr. King's treatise affords most pleasant and profitable reading, but it is matter rather adapted to the kidney of the antiquary than food for the mind of the mineralogist. Indeed, on the whole, it is a work admirably suited to the drawing-room table, and an occasional "dip" into its pages is accompanied by profitable information on most absorbing topics. The history of the remarkable diamonds is comprehensively stated, and the accounts of diamond-cutting, and of the various operations of the jeweller and lapidary, are given fully and with clearness. Mr. King corrects the too popular notion that the Koh-i-noor is the largest diamond, by showing that, in respect of size, the Mogul carries off the palm, of which he says that it is "incomparably the largest authentic specimen of the diamond ever yet discovered." The illustrations are not numerous, and it must be confessed are rather poor. In other particulars, however, the physical characters of the work are luxurious, and reflect credit on the publishers.

LOOMIS'S ASTRONOMY.†

PRINTED in somewhat blurred type, and bound in antiquated covers, the first idea which Professor Loomis's book gives us is that it is a copy of old "Brinkley's" treatise. On turning over its pages, however, it soon becomes evident that the American volume is one which is clearly written,

* "The Natural History of Precious Stones and of the Precious Metals." By C. W. King, M.A. London: Bell & Daldy. 1867.

† "A Treatise on Astronomy." By Elias Loomis, LL.D., Professor in Yale College. New York: Harper Brothers. 1868.

does not trench too much on theoretical details, avoids mathematical considerations as much as possible, and withal embraces much of the work of modern astronomers. Considering the multitude of astronomical treatises which have been lately published in this country, we fear there is hardly room for competition by the American treatise, but we must nevertheless record a good opinion of its worth.

FRICTIONAL ELECTRICITY.*

SIR SNOW HARRIS is so well known as one of our best students of Frictional Electricity, that all will learn with regret that he was not spared to complete this his last treatise. The work, however, has fallen into careful and able hands in being consigned for editorship to Mr. Chas. Tomlinson, of King's College. Mr. Tomlinson is himself a physicist of much repute, and a writer of known and tried ability, and Sir S. Harris's work could not have found a better trustee. In addition to arranging the MS. and seeing it to press, Mr. Tomlinson has written a pleasant and touching memoir of the author. In this he extenuates nothing, and sets down nought in malice; and while he fully exposes the qualities of his old friend, he by no means conceals those defects in his character which may be said to have influenced the propagation of his theories. The book as it stands is unquestionably the most complete essay on frictional electricity which our language possesses, though if we were to be very critical we should pause to question the author's departure from the modern system of terminology, and his tendency to regard electricity as something *per se* apart from other forces. He seems to us also to have given too little attention to the importance of regarding all varieties of electric force as so many wave-phenomena of different varieties. His book is amply illustrated, and, containing the fruits of a vast experience, cannot but be referred to by students of the science. For his determined efforts to compel the navy to adopt lightning-conductors in ships, the thanks of the whole nation are due to Sir Snow Harris.

MODERN CHEMISTRY.†

HERE we have two works on Elementary Chemistry as different in style and in degree of usefulness as it is possible to conceive. In the first the author endeavours clearly and tersely to lay before the student the striking phenomena of modern chemistry, and the laws which are educible from

* "A Treatise on Frictional Electricity in Theory and Practice." By Sir W. Snow Harris, F.R.S. Edited by Charles Tomlinson, F.R.S. London: Virtue & Co. 1867.

† "First Principles of Modern Chemistry." By U. J. Kay-Shuttleworth. London: Churchill, 1868.

"The First Step in Chemistry." By Robert Galloway, F.C.S. Fourth Edition. London: Churchill.

them. Adopting the philosophic method, though not pursuing it as thoroughly as he might, the author leads the student by a proper gradation from facts to generalisation. Had he given more attention to the subject of organic chemistry he would have rendered his little book more complete. But even as it is, his work is one deserving our warmest commendation.

Of a different type is Mr. Galloway's "First Step." We really cannot award much praise to Mr. Galloway for his labours. Indeed, we think that by "putting a new piece on an old garment" the author has produced a work whose constituents are so antagonistic that the result is absolutely valueless. For instance, the greater part of the volume is based upon the old system of nomenclature, and assumes its absolute correctness; while the second part of the volume deals with the new system. Now, since these are entirely incompatible, we are puzzled to think what first step such a mode of teaching is likely to lead to. There are undoubtedly two sides to every argument; but by laying the two sides before young people, and by giving an undue prominence to that which is by common consent the weaker, how is Mr. Galloway likely to render the study of chemistry either intelligible or profitable to his junior readers? We cannot help expressing the opinion that Mr. Galloway's last effort is a serious mistake, likely to be attended with unfortunate results to his pupils. We can only hope that in his fifth edition he will expand the second and erase the first portion of the present work.

BRITISH SOCIAL WASPS.*

THERE has long been wanted a good popular illustrated book on British wasps, and we are happy to say that in the volume before us this want has been thoroughly and satisfactorily met. In the pages of this excellent little treatise Dr. Ormerod, with a loving pen, has written the history of creatures which have been his companions for years. And he has dealt so minutely with every division of his subject, and has illustrated his remarks by so many admirable and artistic engravings, plain and coloured, that we feel certain the result will be to remove much of the ill-feeling which is vented on this unhappy group of Hymenopterous insects. We cannot analyse the author's labours, but we may briefly state the headings under which he has dealt with the British wasp. First we have an introduction, in which the general relations of this department of Natural History are discussed. Then come chapters on the classification and distinction of the several species. Next we have four chapters devoted to the anatomy and physiology of *Vespidæ*. Chapter VII. describes the form and construction of the wasp, Chapter VIII. the general economy of the colony, and finally, Chapter IX. is given up to an account of a number of very remarkable experimental inquiries carried out by Dr. Ormerod. The anatomy and physiology occupies the greater part of the work, and is exhaustively treated. Indeed, this por-

* "British Social Wasps." By Edward Latham Ormerod, M.D., &c. London: Longmans, 1868.

tion of the author's inquiries reflect the highest credit on him, and will be read by "those who work with the microscope" with no small degree of pleasure and improvement. Authorities, ancient and modern, have been ransacked on all sides, and original and independent researches are added by the author. The literature of the wasp receives a fair share of attention; and, withal, the style is so easy and scholarly, and the technicalities are so few, that we confess to regarding Dr. Ormerod as one of the best popularisers of science which it has been our good fortune to meet with. If we wished to cultivate a taste for Natural History pursuits, and a mode of rigid scientific observation in a pupil, Dr. Ormerod's book is assuredly one which we should not fail to place in his hands.

MIND AND MATTER.*

OUR English *Charivari* once gave a popular definition of the relations of what are styled mind and matter, and it appears to us that it was but a happy satire on a certain class of metaphysicians. It was as follows:—"What is mind?—No matter. What is matter?—Never mind." Now the object of the author of this book gives Mr. Punch's answer, but he does not make the assertion that mind is immaterial without going through a somewhat elaborate process of demonstration. Mr. Wyld is by no means a writer to be despised. To a difficult and obscure subject he brings a clear style of expression, and a certain superficial acquaintance with physiological facts. With these powers, then, he strives to demonstrate a proposition utterly impossible to *prove*, and which, we may also remark, is absolutely at variance with the results of modern investigation. He thinks—so far as we can see—that he has started a novelty in questioning the existence of force and matter as united facts, but we think he will find that in this respect Faraday has been before him. We by no means admit the author's conclusion, but we would not desire to bias our readers against him. Let them take up his book, and read it for themselves. It is instructive; but we think it would be as well if, when next Mr. Wyld approaches the subject, he would, *in limine*, state distinctly what he understands by the term "mind." This would help to make the controversy a short one.

A WIT, A POET, AND A HISTORIAN.†

DR. STIRLING'S essays hardly come within the range of our criticism, but, inasmuch as they include a chapter in which the opinions of

* "The World as Dynamical and Immaterial." By R. S. Wyld, F.R.S.E. Edinburgh: Oliver and Boyd, 1868.

† "Jerrold, Tennyson, and Macaulay." By J. H. Stirling, LL.D. Edinburgh: Edmonston and Douglas, 1868.

Coleridge and De Quincey on Kant are fully discussed, we call attention to them. The author points out certain particulars in which the two English thinkers have done very scant justice to the opinions of the great German metaphysician.

THE IRISH SWITZERLAND.*

SIR W. WILDE is, *par excellence*, the archæologist of Ireland, and in the handsome volume which he has been good enough to send us, he has—if we may use an Hibernicism appropriate to the occasion—given us the history of its pre-historic remains. In describing the events of interest which occurred in the course of his tour, he has furnished the future explorer with a pleasant and well-written guide-book to the west of Ireland. This cannot fail to be of service, and we should think it must be especially valued by the English "tourer," as the Dublin "carman" is wont to style him. We cannot say much for the science of this volume; indeed, any opinion on this score must be adverse to the author, always save and except as to the one subject of archæology. Having ourselves "done" Connemara on foot, in days when steamers on Lough Corrib were undreamt of even by the visionary, we can testify to the high botanical and geological interest of the whole country from Lough Mask to Clifton. Yet we regret to find that Sir W. Wilde says very little on this point to satisfy the ardent naturalist. The illustrations are pretty, and the mechanical features of the book are creditable to Irish "publishing."

AMERICAN CHEMISTRY.†

THE character and mode of arrangement of this work are so different from our English text-books that at first sight one is disposed to think the general plan an objectionable one. A little reflection, however, will show that there is a reason, and a good one, for all this. The aim of the authors is to provide the student with a work which shall be a companion to the laboratory, not merely for the purpose of pursuing analyses, but for the study of chemistry in its widest sense. In America, it would seem that the principles of general chemistry are not taught in the lecture-room, but in the laboratory, and that the student, by a course of experimental research and inductive reasoning, is led through the successive steps by which the science

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* "Lough Corrib, its Shores and Islands, with Notes of Lough Mask." By Sir W. Wilde, M.D. Dublin: M'Glashan and Gill, 1867.

† "A Manual of Inorganic Chemistry, etc." By Ch. W. Eliot and F. H. Storer, Professors in the Massachusetts Institute of Technology. London: Van Voorst, 1868.

reached its present condition. This is certainly the truest system of teaching. The student by its means is not compelled to base his opinions on authorities, but absolutely sees for himself the basis on which the principles of his science are laid. It is eminently characteristic of the book before us, which is just such a companion as the student ought to have. But till our method of teaching is assimilated to the American mode, we fear the book will not find many English readers, unless among those engaged in lecturing. Let us hope that we may soon find the principles of chemistry taught in the laboratory by English as well as by American chemists.

THE AMERICAN INDIANS.*

MR. CATLIN—the famous Catlin of our childhood—has issued two little popular works on the habits and character of the North American Indians, which we should like to see in the hands of young folk, instead of the terrible tales of dwarfs and giants which now reign supreme in the nursery. Mr. Catlin's style is occasionally of too peculiarly ornate a nature, but on the whole his books are those which may well be placed in the hands of boys. They are full of exciting narrative, and are yet devoid of absurd fiction and exaggerated exploits and incident; in addition, they are healthy in tone and morals.

A Year-Book of Facts, by John Timbs, F.S.A., London, Lockwood, 1868, contains its usual cuttings from the scientific journals of the year. Mr. Timbs, however, falls into an error in implying the resignation of the Editor of this Review, as he does, in quoting from the *Times* a letter in which a misstatement to that effect was made.

Wholesome Fare; or, The Doctor and the Cook. By Edmund S. and Ellen J. Delamere. London: Lockwood. This is something out of the ordinary groove in which cookery books are written. It is practical, and it is somewhat scientific. It is admirably adapted to small households where the proverbial two ends meet, but by no means overlap, at the end of the year. We have no great faith in the physiology of the introduction: it is nicely done, and is in its way an excellent specimen of the scientific *réchauffé*; but we should be very sorry to adopt a scale of diet upon the rigidly physiological method it involves. However, this is only the upholstery of the book. The pages, which are nearly 1000 in number, contain sound practical directions, and avoid those Francatellian impossibilities in which cookery books generally abound. On the whole, so far as any recommendation of ours is of weight, we can conscientiously afford it to "Wholesome Fare."

* "Life among the Indians." By George Catlin. "Last Rambles among the Indians of the Rocky Mountains." By George Catlin. London: Sampson Low, 1868.

Bible Animals. By the Rev. J. G. Wood, M.A. London: Longmans. We have received the first three numbers of this interesting treatise, but must reserve our notice till the completion of the work.

Man's Origin and Destiny, London, Trübner, and *The Life of Sir John Richardson,* Longmans, reached us too late for notice in *this* number.

We have also received copies of the following American periodicals:—The American Naturalist, Dec. Jan. Feb.—The Riverside Magazine.—The Halifax Mining Gazette.—The New York Telegraph.

SCIENTIFIC SUMMARY.

ASTRONOMY.

IT cannot be said that anything very unusual has taken place in astronomical matters since our last summary. We have little to record in the way of discovery or research. More perhaps has been done in preparation for what is to come, and the great eclipse of the sun on the 17th of August next claims the foremost place. A very long period will most probably elapse before so long an interval of total obscuration of the sun's light will again occur; it is not surprising, therefore, that preparations on a large and complete scale are now in progress for taking advantage of an event which may prove, if the weather be favourable, of the greatest utility in elucidating the phenomena of the solar photosphere. On the occasion in question, the moon will be but six hours from its perigee, while the sun will be near its apogee: a combination of circumstances which increases the apparent diameter of the former, and lessens that of the latter. Owing to this the darkness will be of more than usual duration, indeed, at some points in the path of the shadow it will continue for nearly seven minutes. A very complete chart of the path of the eclipse has been issued by the *Nautical Almanac* office, with diagrams of the solar disc, at various places on the line of shadow, giving the points on the sun's limb where the first and last contact will take place; also the Greenwich mean time of the middle of the eclipse at these places. From near Aden, the central line extends to the southern coast of New Guinea, crossing Hindostan, the Bay of Bengal, the Malayan Peninsula, and the Gulf of Siam. M. Leverrier recommends, as the south-west monsoon will be blowing at the time, rendering observations somewhat uncertain, on account of clouds, except on the east of mountain ranges, that some of the French vessels, in the Gulf of Siam, should search for a suitable place on the eastern side of the Malayan Peninsula, in which to make a complete series of observations. With regard to England, two well-equipped expeditions have already proceeded to India, for observing the eclipse. That originated by the Royal Astronomical Society will be conducted by Major Tennant, who has gained a large amount of experience in solar photography from Mr. De la Rue; he will be assisted by some of the men of the Royal Engineers, who, through the kindness of Mr. De la Rue, have been through the whole process of taking the negatives, enlarging, &c., at his observatory at Cranford. A reflecting telescope, of the Newtonian form, will be used for photographic purposes, while, for stereoscopic and polarising experiments, the telescope of the society, lately employed by Mr. Howlett, has been fitted with the necessary apparatus. The other

expedition is sent out by the Royal Society, and the expenses defrayed by a Parliamentary grant. It will be superintended by Lieutenant John Herschel (a son of Sir John Herschel), who is provided with a telescope of five inches aperture, with spectrum apparatus, driving clock, &c. Another telescope is fitted for observations of polarised light, while smaller instruments are provided for observers stationed at different points. Lieutenant Herschel will confine his attention to observations of the spectrum of the corona, and red prominences, and to an examination of the light of these objects, for polarisation. After his arrival in India, until the period of the eclipse, he will examine, prismatically, the brightest of the southern nebulæ, for which purpose the instruments taken out are perfectly suitable.

The Royal Astronomical Society held their annual general meeting on the 14th of February last, when it was stated that the number of the Fellows was then 529, and that the funded property of the society had increased. The *Gold Medal* of the Society has been awarded this year to M. Leverrier, for his Solar and Planetary Tables, which include Mercury, Venus, the Earth, and Mars, and have superseded all others for calculating the places of the bodies referred to. In awarding the medal, the retiring President, the Rev. Charles Pritchard, gave a résumé of M. Leverrier's life and labours; he showed the difficulties with which he had to contend at the outset of his career, and the successful efforts made by him to overcome them. When he entered on his duties at the Paris Observatory, the instrumental equipment was very defective; up to 1800, no transit instrument of any description had been employed, and that used up to 1828 was inferior to the Greenwich instrument of seventy years before. M. Leverrier set to work vigorously to repair this state of things, fired with the ambition to enter upon equal terms on a contest with other nations in the pursuit of his noble science, and with a result, the value of which the annals of the observatory now furnish full proof. The observatory of each nation taking a distinct line—Pulkowa, that of sidereal research; Greenwich, the moon and navigation—Leverrier adopted the idea of recomputing the places of the planets, a scheme involving vast labour. He again reduced the best observations of Bradley, and others, at Greenwich, from 1750 to 1850; he recomputed the observations of Bessel; he extended the formulæ for calculating the planetary approximations beyond the point at which La Place thought the perturbing forces might be disregarded. In fact, he published a complete reinvestigation of the whole theory of planetary motion, and then applied himself to the construction of those tables which have superseded all others in the computations for the *Nautical Almanac.* Leverrier has made a great advance in accuracy upon all previous results, and the average discordance between observation and prediction, now remaining, does not exceed a small fraction of the diameter of each of the three planets named. Leverrier's labours in ascertaining the solar parallax, on the secular variation of the moon's mean motion, and in other matters having been alluded to, the President delivered the gold medal to Admiral Manners, to transmit to the distinguished astronomer to whom it had been voted, who regretted that he was prevented by the state of his health, and the recent death of M. Foucault, from coming to receive it in person.

The November Meteors of 1867.—Since the publication of our summary in

the January number of the POPULAR SCIENCE REVIEW, more detailed accounts have been received from abroad of the periodic meteor shower of November last. Professor Daniel Kirkwood, of Bloomington, Indiana, in spite of the hazy state of the atmosphere, which obscured all stars but those of the first magnitude, observed 525 meteors in eight hours. Commander Chimmo, of H. M. S. *Gannet*, at five in the morning of November 14, when rounding the north point of Martinique, saw an immense number of bright sparks falling into the sea, with occasionally a meteor of large size bursting and lighting up the whole heavens. The same observer states that the shower was more distinctly seen at Trinidad, where, on the same morning, from two o'clock to daybreak, 1,600 meteors were counted, and about eight per cent. were thought to have been missed. At Nassau, Bahamas, Captain Stuart and other observers counted about 1,100 meteors between 2h. 30m. and 4h. 45m. on the morning of the 14th, but only a portion of the sky was noticed. At the Cape of Good Hope, Mr. G. W. H. Maclear observed the following meteors:—On the night of November 12th, 3 meteors; 13th, 9 meteors; 14th, 17 meteors, principally from Leo; 15th, 5 meteors. At the meeting of the Astronomical Society in February last, Mr. Pritchard said that, although the meteors were not seen in this country, the accounts coming in from America prove that the display was little, if at all, inferior to that of 1866. The orbit of these meteors had been investigated by Professor Adams, who has shown that Professor Newton's period of 354·6 days, and his other shorter periods, fail to satisfy the motion of the node, and that the meteors have undoubtedly a period of 33¼ years.

The Planet Mars.—To determine with greater exactness the period of rotation of this planet, which is interesting to us as being not only the nearest to the earth, but, as far as we have means of judging, bearing the greatest resemblance to our globe, is a problem which Mr. Proctor has lately set himself. Taking advantage of the views made by Mr. Browning in January and February 1867, he has estimated the rotation-period by means of an interval of nearly 201 years. From the results of the calculation of three long periods, viz. from March 12, 1666, 12h. 20m. (astronomical time and new style), to April 24, 1856, November 26, 1864, and February 23, 1867 respectively, Mr. Proctor deduces the rotation of the planet as taking place in 24 hours 37 minutes and 22·735 seconds.

Heat given out by the Moon.—The influence of the moon upon the weather has been a disputed point from the earliest times. By some it has been entirely denied, while others have attached to it an importance apparently insufficiently founded on experience. Our readers will, therefore, be glad to hear that some facts relative to the heat given out by our satellite have lately been brought before the Astronomical Society in a tangible shape by Mr. J. P. Harrison, from which further observation may possibly deduce very valuable results. In his paper on the subject, Mr. Harrison shows that the heat acquired by the moon from the sun, and radiated to the earth, is what Professor Tyndall calls "dark heat," or what would be almost wholly absorbed by our atmospheric vapour. This would raise the temperature of the air above the clouds, increase evaporation from their surface, and diminish their density, raise them to a higher elevation, and, under favourable circumstances, disperse them. In either case *a sensible fall* would take

place in the temperature of the air near the ground. This occurs at the period of lunation when the moon has acquired the greatest amount of heat it can receive from the sun, which is when the half-moon then illuminated has been subjected to solar radiation for about 265 hours, or at the third or last quarter. Precisely opposite results will occur at the time of minimum heat in the moon. We have heard of experiments to test the heat given out by the full moon; and, if we mistake not, it was Professor C. P. Smyth, in his Teneriffe experiment, who found that it was so little as not to amount to more than would be given by a wax candle at the distance of fifteen yards. Mr. Harrison shows us that this was not the right time to expect to discover heat from our satellite; the fact being also that, at the time when most heat was really given out, the effect upon the earth's surface was that a lowering of the temperature was produced. In confirmation of what was stated, Mr. Harrison showed the tabulated results of temperature at Oxford, Greenwich, and Berlin, taken for several years at each place, which agreed in proving that, at the time when by calculation the moon must have acquired the greatest heat, the average temperature on the earth's surface was lower, accompanied by a dispersion of cloud.

Large Telescopes.—In our January number we mentioned the completion of the large object-glass of 25 inches diameter, which Messrs. Cooke had been grinding for Mr. Newall. The equatorial mounting for this immense glass, which weighs, we believe, without its cell, no less than 146 lbs., is now complete, and it is expected that the instrument will, during the present year, reach Madeira, where it is to be erected and placed under the superintendence of Mr. Marth, whose familiarity with large telescopes, gained while at Malta with Mr. Lassell, is a guarantee that the new instrument will be in competent hands. Mr. Newall will complete the establishment by the addition of a 7-inch transit circle. The great reflector, by Mr. Grubb of Dublin, now in course of manufacture for the Melbourne Observatory, also approaches completion, and, both in optical definition and mechanical arrangements, is all that can be desired. The speculum is 4 feet in diameter; the driving clock does its work with the greatest precision, and the necessary apparatus for photography and spectroscopic examination is to be added to the instrument. The means of sheltering the telescope from rain and dust are not yet definitely settled, but a dome of 46 feet diameter is suggested.

Suspected Change in one of the Nebulæ.—The Rev. H. Cooper Key has been making a series of observations on the planetary nebula, 45 Herschel, iv. Geminorum, with a silvered glass speculum of 18 inch aperture, and 10 feet focal length, using an eye-piece giving a power of 510. This object presented to the Herschels a uniform nebulous disc with a stellar centre, but no ring; Lord Rosse saw one ring only; in Mr. Key's telescope two rings were distinctly visible. Mr. Huggins considers the observation important as showing a definite change in these objects; the central star of the nebula gives a continuous spectrum, and possibly the luminous haze surrounding it also, but of that Mr. Huggins is not so certain, the difficulty of getting spectrum observations of these faint objects being so great.

The Lunar Crater Linné has been diligently observed by the Rev. T. W. Webb during the last few months. On the 3rd of February, during an

interval of good definition, Linné presented the appearance of a minute deep crater, with black interior shadow, lying in the centre of the usual white cloud. The crater appeared from the shadow to have great depth and

We have to close our summary by recording the severe loss the astronomical world has sustained in the death of the *Rev. W. R. Dawes.* For a considerable time he was with the late Mr. Bishop, at his Observatory in the Regent's Park; he then had an observatory of his own at Wateringbury, from whence he removed to Haddenham, in close vicinity to Admiral Smyth and Dr. Lee, in connection with whom he will be recollected by all readers of the *Bedford Catalogue.* With an eye of surprising acuteness, and telescopic means of the greatest power, Mr. Dawes has enriched astronomy with many independent discoveries and observations of the greatest value. During the last few years he had been engaged in completing the catalogue of his measures of the Double Stars, which is published in the 35th volume of the *Memoirs* of the Royal Astronomical Society. He had been very seriously ill a short time previous, but rallied, and observed in reference to this work that he thought he should be permitted to live to complete it. He was, we think, justly considered to be our first English observer; anything which he stated could be seen by himself was implicitly believed, and it is doubtful if a single instance has occurred in which his observations have not been confirmed by the employment of more powerful instruments. Of the most pleasing manners and kindly address, he would give the utmost patience and attention to any subject brought before him, and would seize at once upon the points most requiring notice. Mr. Dawes was a Fellow of the Royal Society. He received the gold medal of the Astronomical Society, in 1855. He died on the 15th of last month, at the age of 69.

BOTANY AND VEGETABLE PHYSIOLOGY.

Action of Light on Vegetation.—An important and philosophic paper has been sent in to the French Academy by M. Dubrunfaut, in which the author describes the results of numerous experiments, and in some measure corroborates the conclusion before arrived at by M. Cailletet. It will be remembered that, according to M. Cailletet, the red and yellow rays of light are the most favourable in promoting the decomposition of carbonic anhydride by plants. Light which is passed through a solution of iodine in carbonic disulphide prevents decomposition altogether. Under the influence of green light, not only does no decomposition take place, but new quantities of carbonic anhydride are formed. A fresh leaf exposed to sunlight, under a bell-jar of green glass, exhales nearly as much carbonic anhydride as it would in the dark. Regarding the facts as established, M. Dubrunfaut proceeds to generalise upon them, and endeavours to establish a law, by which the number of "foot-pounds" of work done in decomposing carbonic acid may be established. At present he confines himself to pointing out the existence of such a law, and in concluding his paper, he makes the following remarks: If we admit that in the act of assimilation of

carbon by plants, the light absorbed by the leaves is transformed into so much mechanical or chemical work; and if we further admit that the plant by itself is unable to dissociate the carbon and oxygen of carbonic acid, and that this dissociation is only possible under the influence of light, we must also admit that the force required to produce such a result is necessarily greater than the force which determines the combustion of the carbon, and consequently that it is greater than the mechanical work represented by the heat developed under these conditions.—Vide *Comptes Rendus*, Feb. 17.

Analysis of the Tissues of Plants.—The many difficulties in the way have hitherto prevented a satisfactory chemical qualitative or quantitative examination of plant tissues. These difficulties have at last, however, been overcome by MM. Frémy and Terreil, who have just published a memoir describing the methods and stating their results. They divide the woody portion into three separate classes, and give the following account of their chemical qualities. The first portion of the wood is not to be confounded with any other ligneous tissue, for it is insoluble in even concentrated sulphuric acid, and it is characterised by these reactions: chlorine water first transforms it into a yellow acid, and then dissolves it, nitric acid acts similarly, but even concentrated caustic potass does not dissolve it. This part is termed the *ligneous cuticle.* It is not identical with the cuticle of the leaves, but it has many analogies with it. It may be at once distinguished by its complete insolubility in concentrated sulphuric acid, and its ready solubility in chlorine water. The second portion of the woody tissue is that which M. Payen has designated under the name *incrusting substance.* It is most likely found in the interior of the fibres and cells. This substance is at once identified by its ready solubility in sulphuric acid, which it blackens, and by its insolubility in chlorine water. The third part of the woody tissue is the *cellulosic part.* When this is pure it dissolves—without giving any colour—in concentrated sulphuric acid, and produces a liquid which is not precipitated by water, and is with difficulty acted on by nitric acid. We have shown how the French chemists make a qualitative analysis of these constituents of woody tissue. For the quantitative method we must refer readers to the original paper.—Vide *L'Institut*, March 1[illegible]

The Venation of the Umbelliferæ.—The paper which was lately read before the Microscopical Society by Mr. T. Gorham, is one which is of much interest, and which shows what a large field remains for work, even in a subject like botany, which has been so much and so carefully studied. Mr. Gorham, by using a low microscopic power, has thrown considerable light on the arrangement of the nervures of the leaves of umbelliferous plants, and he formulates the following conclusions:—1. That the distribution of the veins in Umbelliferæ is very variable in different species, but constant and highly characteristic in each species. 2. That many of the leaves of this order have a venation like that in other leaves, and may be classified with them; but that a considerable number of them, on the other hand, have a kind of venation peculiar to themselves, which does not find a place under any of the divisions that have heretofore existed. 3. That this peculiarity consists in the existence of a vein at the very edge of the leaf itself, and which, more or less, entirely fringes its whole margin. 4. That this marginal vein is to be found certainly in one half, if not more, of the species

belonging to the Umbelliferæ, and hence that it may be said to constitute a form of venation peculiar to this order, and to give a character to it which does not belong to other orders of plants. 5. That when a leaflet is placed between two pieces of glass, and examined with a low power of twelve diameters, the vein becomes distinctly visible. 6. But that it is also visible, even to the naked eye, in certain of the species—*Eryngium maritimum*, *E. campestre*, *Silaus pratensis*, &c. 7. And finally, that it is possible that a more attentive study of the venation of leaves might prove of considerable assistance in the classification of plants.—Vide *Quarterly Journal of Microscopical Science*, January.

The Proper Vessels of Plants.—M. A. Trecul laid a memoir before the French Academy, at its meeting on March 9, in which he adds new facts to his original observations on the subject of the proper vessels.

Polymorphism in Lichens.—Those of our readers who were interested in Dr. Braxton Hicks' valuable paper on the lower Algæ, which appeared in one of our back numbers, will be glad to learn that the philosophical views therein expressed—as to the possibility of many of the so-called species being developmental phases merely, have been fully corroborated in an excellent article by Dr. Lauder Lindsay. This article appears in the last *Microscopical Journal*, and the following observations which we quote from it show that Dr. Hicks is not alone in viewing many of the so-called species with suspicion:—"There are many other forms of polymorphism in the reproductive organs or bodies of lichens, which are of great interest to the philosophical botanist. Our knowledge thereof consists, however, of fragmentary and isolated observations, casually made in different parts of Europe. They are not more numerous, I believe, simply because Lichenology has been hitherto almost exclusively studied by mere systematists—by species-makers, who describe *phases of plant-life* as species, genera, or groups! Philosophical biographers of lichens have been very few—physiologists, I mean—who have given themselves the time-consuming, and often fruitless, task of studying all the phases of development of even a single lichen. Such labour I believe to be of the most recondite character; and it is, perhaps, not surprising that lichenologists should always have preferred the infinitely more easy task of discovering and describing so-called *new* species, three-fourths, however, whereof will, probably, ultimately be shown by the philosophical lichen-biographer to be merely *forms* or *conditions of growth*, undeserving, for the most part, separate nomenclature."

The Development of Agaricus.—Professor Oersted's fine memoir, which had remained so long untranslated, has been reproduced in English by the editor of the *Microscopical Journal*, to whom naturalists are much indebted. The following are a few of the more striking conclusions at which the author has arrived:—1. The mycelium of this fungus is formed of long dichotomously branched tubular cells, without septa, united into a loose web, and with so thin and soft a membrane that it has almost quite the character of a mucous membrane. 2. From the mycelium cells proceed both vegetative organs of propagation or bud-cells and organs of fructification. 3. The organs formed as bud-cells have been previously described as an independent species amongst Hyphomycetes (*Cephalosporium macrocarpum*). 4. The female organ of fructification is a reniform oogonium, which is curved down against the

mycelium-filament, whence it originates, with its apex pressed towards it. The male organ of fructification consists of two filiform antheridial cells proceeding from the base of the oogonium. 5. After fertilisation several oogonia in union give rise to the formation of a receptacle. The oogonia are included in the dense filamentous tissue which forms the first rudiments of the receptacle, without (as it appears) their undergoing any transformation. 6. The stem is that part of the receptacle which is first produced, afterwards the pileus. This is at first regular, horizontal, and attached to the stem by the middle of the under surface, afterwards it becomes oblique, vertical, and attached to the stem in the neighbourhood of the margin.

Development of Cellular Tissue in the Spiral Vessels.—It was announced many years since by Herr Schleiden, that the filling up of the air spaces of the spiral tissue which occurs in certain plants as they increase in age, was due to the multiplication of the contiguous cells, and not to development of cells within the spirals. Subsequently the opinion was decidedly opposed by Herr Böhm. It is therefore of interest to note that, in a paper recently read before the Academy of Sciences of Vienna, Herr Unger conclusively showed that Herr Schleiden's view is correct. Herr Unger attributes the multiplication of the cells to the influence of the oxygen which enters the tissues from the atmosphere.—Vide *L'Institut*, No. 1784.

Colouring Matter from Decayed Wood.—Some four or five years ago M. Fordos called attention to a green colouring matter which he had obtained from dead wood. M. Rommier has now come to investigate this substance, and has found, what we are surprised was not thought of before, that the new substance is a species of fungous growth, and does not really proceed from the decaying wood. M. Rommier thinks his green substance is distinct from that described by M. Fordos, and he gives it the name of *Xylindeine.* He states that it differs from the old substance xylochloric acid, in that it resembles indigo in undergoing reduction in the presence of alcohol, potass, and glucose. It has also the valuable property of being easily fixed, and thus forming a dye of a brilliant blue-green colour, resembling Chinese green. The oak is the tree on which this substance is most frequently met, but it is occasionally found on other trees also. For a detailed account of its mode of preparation, vide *Comptes Rendus*, January 13.

Absorption of Gases by Plants.—M. Lechartier, following up Van Tiegehm's researches, has discovered one or two facts of interest with regard to the absorption of air by aquatic plants. The experiments were carried out upon the water-lily (Nymphæa), and are fully recorded in his published paper. The result seems to be this. The gas contained in the stem is richer in carbonic acid than the gas found in the petiole. Even at the same point in the interior of the plant, the quantity of carbonic acid diminishes, and that of oxygen increases in proportion according as the solar action is prolonged. But the same difference in composition is always observed between the gas which is evolved by the petiole, and that which is disengaged by the deeper parts. The general conclusion would seem to be, that the gases are absorbed in the deeper parts, and exhaled by the more superficial tissues.—Vide *Comptes Rendus*, t. lxv. No. 26.

CHEMISTRY.

A New Process for Organic Analysis has been described by Herr M. F. Schultze, and is founded on the analysis of the gaseous products. Herr Schultze burns the substance to be analysed with chlorate of potash in a tube, previously exhausted and sealed, and he states that its advantage is the small amount of material necessary for the operation. The following is the new mode. Herr Schultze first introduces the mixture, together with rather more than enough chlorate for complete combustion, into a combustion tube, sealing it at one end, and drawing it out at the other; after having exhausted and measured the pressure of the remaining air, he seals the tube, shuts it up in a gun barrel, and heats it to a dull red heat for twenty minutes. When cold, he breaks the point of the tube under mercury, and collects the gas in a eudiometer. By measuring the quantity of carbonic acid formed, and absorbing it by potash, are to be found all the elements necessary for the calculation of the composition of an organic matter containing only carbon, hydrogen, and oxygen. If the carbon absorbs its proper amount of oxygen, and the compound is a body corresponding to a hydrate of carbon, such as starch, the gaseous material obtained is exactly equal to the amount of oxygen supplied by the chlorate of potash used. If more gas be found, it is because the body contains more oxygen than is needed to burn all its hydrogen; if, on the contrary, there is less gas, it is because the body contained an excess of hydrogen with respect to its oxygen in the constitution of water. Vide *Zeitschrift für Anal. Chem.* t. v. p. 239; and new series, t. iii. p. 391.

Action of Ozone on Sensitive Photographic Plates.—In a paper read before the Dublin Chemical Club (Dec. 12), Dr. Emerson Reynolds stated that he had been performing some experiments upon the above subject, and that he had found that when the latent image (i.e. the image before it is developed) was submitted to the action of ozone, it was completely obliterated—not only was it impossible to develop the image, but a second image might be retaken in the camera upon the same plate. The author remarked that this was against the theory which might be called the mechanical theory of photographic images.

Simple Test for Alkaline Carbonates in Water.—A simple test of the presence of these salts in spring or river water has been described by a writer (J. W. Y.) in the *Chemical News.* This test is as follows, and would constitute an excellent lecture experiment. It is dependent on a logwood reaction. The experiment may conveniently be performed by adding an equal quantity of the logwood solution to the water or waters to be tested, contained in glass jars or beakers, placed on white paper, a similar jar of distilled water being used for comparison. The solubility of carbonate of lime in pure water may be shown by placing some pulverised calc-spar on a properly purified filter, and allowing distilled water to pass through it; on adding a few drops of the logwood solution to the filtrate, a deep purplish red colour is immediately produced. An alcoholic solution of alizarine may be used instead of the logwood decoction; with distilled water a yellowish colour is produced, but if any alkali or alkaline earth be present, a violet

colour is developed, especially on application of a gentle heat. Of course in using the above tests to show earthy carbonates in water, care must be taken that no alkali is present.—Vide *Chemical News*, Dec. 27.

The Gallic Fermentation has been very fully investigated in a memoir read before the French Academy, by M. Van Tieghem. This chemist adopts the following conclusions:—1. Tannin does not undergo the metamorphosis when protected from the atmosphere. If a series of flasks be filled entirely with a solution of tannin or a filtered infusion of nut-galls, and placed in vacuo for 24 hours, then saturated with carbonic acid, carefully corked and heated, and finally sealed while hot, the solution will remain unchanged for any length of time. The transformation of tannin into gallic acid is not, then, due to the pre-existence of a soluble ferment. 2. Tannin does not undergo metamorphosis by simple contact with the air. A solution of tannin introduced into a series of flasks drawn out at the neck and curved, boiled for some minutes, and left in a quiet place at a temperature of about 25° C., will remain unchanged for any length of time. 3. For tannin to undergo the metamorphosis, the development of a species of fungus in the solution is essential and sufficient. The gases composing the atmosphere alone effect no change, but the atmosphere carries to the solution spores, and these require for their germination oxygen. Under these influences the tannin splits up into gallic acid and glucose, the elements of water becoming fixed.—Vide *Comptes Rendus*, Jan. 6.

Bleaching on the Continent.—It is stated by a contemporary that the old bleaching powder has given way abroad to a combination of the permanganates and sulphate of magnesia. This method is cheaper and more efficient than the old one.

Manufacture of Sodic Carbonate.—The following method has, we believe, been attempted and found tolerably successful. Steam and the vapour from salt are allowed to operate on silica. The latter is converted into a silicate of soda. By the addition of lime, caustic soda is separated, and by adding carbonic acid this is converted into carbonate of soda.

Viridinic Acid may be obtained direct from coffee by pulverising the beans, extracting the fat with alcohol, and then exposing them to the air. In a few days they become covered with a green substance, which may be removed with alcohol and acetic acid.—Vide *Ann. Chem. Pharm.* cxliii.

An economic source of Acetylene has been suggested by Herr Rieth, in the *Zeitschrift für Chemie* [N. F. 3, p. 598]. In fact, when the flame of a Bunsen's lamp burns below so that it comes within the tube, a large amount of acetylene is evolved. The gases may be collected by a funnel connected with an aspirator. As much as 100 grammes of the silver compound of acetylene have been obtained in twelve hours from a single burner.

The Identity of Ozone.—It has so often happened lately that the question has been asked—Is the substance in the air which acts on the tests Ozone? that we are glad to find a satisfactory answer given to it by Dr. T. Andrews, F.R.S. In a paper on the subject which he published in one of the late numbers of the *Proceedings of the Royal Society*, Dr. Andrews gives many reasons for believing that the atmospheric substance is really ozone. Heat Dr. Andrews regards as furnishing the most convincing testimony. In a communication to the *Philosophical Transactions* for 1856 he proved that

ozone, no matter how produced, is rapidly destroyed by a temperature of 237° Centigrade. An apparatus was fitted up, by means of which a stream of atmospheric air could be heated to 260° C. in a globular glass vessel of the capacity of five litres. On leaving this vessel, the air was passed through a U-tube, one metre in length, whose sides were moistened internally with water, while the tube itself was cooled by being immersed in a vessel of cold water. On passing atmospheric air in a favourable state through this apparatus, at the rate of three litres per minute, the test-paper was distinctly tinged in two or three minutes, provided no heat was applied to the glass globe. But when the temperature of the air, as it passed through the globe, was maintained at 260° C., not the slightest action occurred upon the test-paper, however long the current continued to pass. Similar experiments with an artificial atmosphere of ozone, that is, with the air of a large chamber containing a small quantity of electrolytic ozone, gave precisely the same results. On the other hand, when small quantities of chlorine or nitric acid vapour, largely diluted with air, were drawn through the same apparatus, the test-paper was equally affected, whether the glass globe was heated or not. From this and other experiments Dr. Andrews thinks himself justified in concluding that the body in the atmosphere which decomposes iodide of potassium is identical with ozone.

Professor Frankland's New Method of Water Analysis.—At the meeting of the Chemical Society, on Jan. 16th, Dr. Frankland read a long and extremely interesting paper, in which he detailed the steps of a novel and elaborate system of water analysis, whose precision as gauged by the figures obtained in the author's experiments surpasses that of all processes hitherto described. We cannot, we regret to think, afford space for an account of the whole system, but we will briefly describe the process recommended for the estimation of the organic carbon and nitrogen, as it is about the most useful point, at least to sanitary chemists. The first step is to expel the carbonic anhydride. Sulphuric acid has been found to effect this easily, and for many reasons it has been found the most convenient acid. The solution is boiled for a couple of minutes with a small quantity of sulphuric acid, and then evaporated; for this purpose hemispherical glass dishes have been found far more convenient than platinum. The evaporation is conducted in vacuo, and the residue dried at a steam heat. The heat is applied at the *top* of the bell, by means of a current of hot air; applied in this way the water never boils. Five samples of water could be evaporated at the same time in the apparatus shown to the Society. The residue is mixed with plumbic chromate and transferred to a combustion tube, the dish being rinsed with the chromate; a layer of pure cupric oxide is also added. The tube is sealed at one end and drawn out at the other to about the same size as the tube of the Sprengel's pump which it has to join. The anterior portion of the tube (the position of the layer of pure cupric oxide) is heated, and the tube then exhausted for five or ten minutes. The combustion is now made, and the tube again exhausted, and the resulting gases collected over mercury. A gaseous mixture is obtained, containing free oxygen. After absorbing the oxygen by pyrogallic acid, the volume of the gaseous mixture is accurately measured. The whole of the carbon is obtained in the form of carbonic acid, the nitrogen partly as such, with nitric acid and nitric oxide. The

amount of nitrogen is made up of the nitrogen of the ammonia and the organic nitrogen; the former must therefore be subtracted.

How to Prepare Urea.—The following account of a process for this purpose is given in a paper read before the Chemical Society (Dec. 5) by Mr. John Williams. The author proceeds, in the first instance, to prepare cyanate of potassium by fusion of the cyanide (best commercial quality, containing 90 per cent.) with red oxide of lead, keeping the temperature as low as possible. This product is dissolved in cold water, mixed with nitrate of barium to precipitate the carbonate which it usually contains, then thrown down as lead-salt by adding a solution of the nitrate. The cyanate of lead is easily purified by washing, and is then dried at a gentle heat. For the preparation of artificial urea equivalent amounts of sulphate of ammonia and cyanate of lead are digested together in warm water, the insoluble sulphate filtered off, and the solution when evaporated yields a product of unusually good quality, and of larger amount than by the ordinary plan. Mr. Williams finds that the process is applicable to the preparation of the compound-ureas, using the corresponding sulphate instead of the simple ammonia-salt.

Water-Filtration.—The Silicated Carbon Company, of whose filters we some time since spoke in high terms of praise, have just devised and offered for sale a piece of filtering apparatus which we have no doubt will be found very useful by the poor. It is termed the Silicated Carbon Filtering Tap. In many of the poverty-stricken districts of the metropolis, where water is often stored in water-butts that are perhaps not cleaned once a year, this piece of apparatus will, if used, be found highly beneficial. All the water must travel through the filtering medium placed in front of the tap, and as the tap is made to unscrew into two portions, the "carbon" may occasionally be taken out for cleansing without letting the water "run away."

Action of Light on Chloride of Silver.—M. Morren, of the University of Sciences of Marseilles, has published an interesting note on this phenomenon. Take, he says, a glass tube 3 centimetres in diameter, and from 45 to 50 centimetres in length, close one end and introduce two bulbs, one containing nitrate of silver, the other chloride of potassium, in equal equivalents; fill the tube with a concentrated solution of chlorine in water, then carefully seal it before the blowpipe. Break the bulbs by agitation, when the result will be chloride of silver deposited in an excess of chlorine-water. If the tube be exposed for several days to the rays of the sun, the following facts may be observed. 1st. As long as the liquid preserves the yellow colour given to it by the chlorine, the chloride of silver remains white. 2nd. When this yellow colour disappears by the action of the chlorine on the water under the influence of light, the chloride of silver slowly assumes, not the very deep violet which we see in the reactions of photography, but a red brown, which at first only appears gradually and on the surface, but in time penetrates the entire white mass, provided the tube is sufficiently agitated, and submitted to the action of a bright sun. 3rd. The tube being placed, if not in obscurity, at least in the diffused light of the laboratory, the brown colour disappears gradually, and the chloride of silver reassumes, in all its intensity, its original white aspect. Replace the tube in the sunlight, and the coloration takes place afresh, to disappear again when the tube is returned to the shade, and so on indefinitely.—Vide *Chemical News*, vol. xvi. No 419.

Gallic Acid converted into Tannin.—Herr Löwe has stated that an aqueous solution of gallic acid is converted into tannin by the addition of nitrate of silver.

Testing the Purity of Flour.—M. Rakowitsch has recently proposed a simple mode of examining flour by means of chloroform. He alleges that in the course of a few minutes the following results may be obtained:—The amounts of bran, the moisture between 10 and 25 per cent., the damaged flour, the mineral matters, the ergot of rye, and other impurities. The whole of these are determined by the relative specific gravities of the different substances in chloroform. The flour is simply placed in a tube and mixed with chloroform; the chloroform is enabled to hold in very thorough suspension the pure flour, while the other materials are not thus suspended. By adding spirits of wine of 95°, the flour is precipitated to the bottom of the tube. The more humid the flour, the more spirits of wine must be added, and thus the amount of humidity in the flour is arrived at.—See "Foreign Correspondence" of *Chemical News*, March 13.

The Volumetric Determination of Acetic Acid by means of a standard solution of hydrate of soda is rendered difficult by the fact that the acetate of soda gives a violet tint to the litmus paper, and thus prevents the chemist knowing the exact moment of neutralisation. This difficulty is completely obviated by employing tincture of curcuma as a test. In the presence of free acid it remains yellow, but it turns brown immediately the acid has been neutralised.

GEOLOGY AND PALÆONTOLOGY.

Problems for Devonian Geologists.—The address of the President, Mr. W. Pengelly, in the last volume of the Transactions of the Devon Association, is most interesting and suggestive; but it has an especial importance, because it points out the subjects which local geologists may study with advantage to science. Mr. Pengelly puts the following queries: "What is the age of the crystalline schists at the southern angle of our county? What is the precise chronology of our limestones and associated rocks? Is there, east of Exmouth, a break in the red rocks? Whence came the Budleigh Salterton pebbles? Whence also the porphyritic trap nodules so abundant in the trias? Are our greensands really of the age of the gault? Whence the flints so numerous on our existing beaches? What is the history of our superficial gravels? Are there any indications of glaciation in Devonshire? To what race did our cave-men belong? The solution of, at least, many of these questions must be reserved for another generation of enquirers; and to the young men of the present day I earnestly commend them." We wish other local Presidents would adopt this plan of directing the labours of the provincial geologists.

The Wollaston Gold Medal and Donation Fund were awarded at the Meeting of the Geological Society on Feb. 21st. The gold medal has been given to Dr. Carl Friedrich Naumann, Foreign Member of the Geological Society, Professor of Geology and Mineralogy in the University of Leipzig, &c., in recognition of his labours, extending over nearly half a century, in the

departments of Geology, Mineralogy, Crystallography, &c. The balance of the proceeds of the Wollaston Donation Fund has been awarded to M. J. Bosquet, of Maestricht, in aid of the valuable researches on the tertiary and cretaceous mollusca, entomostraca, and other fossils of Holland and Belgium, on which he has been so long and so successfully engaged.

Time occupied by Denudation in Scotland.—In a paper lately read before the Geological Society of Glasgow, Mr. James Geikie alluded to the immense period of time which must have been occupied during the process of denudation which occurred in Scotland. In concluding an important paper by stating that an enormous amount of time must have been required for even the broader effects of denudation, he asked, How many long ages had rolled away since these islands rose above the level of the Arctic Sea, in which our marine drifts were amassed, and yet, during all that time, how little change had come upon them at the instance of the atmospheric forces? And if the records of the old Arctic condition—the delicate ice-markings on the rocks, the loose incoherent deposits on the hill-slopes and plains—still remained so perfect, notwithstanding the ceaseless activity of the denuding agents—if the mere skin, as it were, and surface-markings of the land were still so largely retained, what should we say to the time required for the growth of that covering itself, and for the production of these strange ice-mouldings and flutings,—and how, above all, could we apprehend (for comprehend we could not) the truly tremendous lapse of time, during which the solid land was gradually sculptured into hills and valleys by the rains and frosts and rivers of the past?

The Formation of Siliceous Minerals.—Mr. John Ruskin continues his paper on this subject in the *Geological Magazine* for January, and illustrates his description by very handsomely executed plates. As we said in a former notice of Mr. Ruskin's labours, we think they show too much of the *ex cathedrâ* character. Mr. Ruskin comes before the scientific world with very little claims to its patience or consideration, and displays a tone and manner which are best summed up in the vulgar expression "bumptious." He never gives himself the least trouble to discuss the views of men whose whole lives have been devoted to the subject in hand, and who have brought to its investigation a knowledge of physical and natural science which Mr. Ruskin is far from possessing. This is to be regretted, both because it is unjust to other workers, and because it prevents even whatever intrinsic merit there may be in Mr. Ruskin's opinions receiving recognition. Mr. Ruskin's doctrines of political economy, as expressed in that desperately dogmatic essay, "Unto this last" have been simply smiled at by unbiassed thinkers, and, unless we very much mistake, his notions on mineral segregation will meet with a similar fate. In his last paper he describes five varieties of silica: jasper, flint, chalcedony, opal, and hyalite; and alludes to two varieties of mineral constitutions, pisolitic and reniform.

Flint Implements of the Yorkshire Wolds.—At a meeting of the Archæological Institute on Feb. 7th, Mr. Evans called attention to a fine collection of these relics, which were then exhibited on the tables. The collection was a most varied one, and exhibited every form of flint instrument, knives, saws, arrow-heads, curved knives, chisels, &c. Sir John Lubbock, who also

made a few remarks, observed that the objects shown were very similar to those found in the tumuli of the wolds, and they were not of the very earliest periods of the first productions of man. The manufacture was exceedingly difficult. No savages of the present day manufactured implements of stone that could be compared to the very oldest known examples.

The Esquimaux as ancient Europeans.—Mr. Boyd Dawkins' theory of the existence of the Esquimaux in Europe during prehistoric times has recently received some support from Professor Nilsson. It has been called in question, however, by Mr. Carter Blake, who, in a letter to the editor of the *Geological Magazine* for February, makes the following observations: "Mr. Dawkins' arguments in favour of the 'affinity' of the old Aquitanian cave-dwellers 'with the Esquimaux' do not appear to be of the strongest value. 'The habit of sculpturing animals on their implements' is common in all savage races; 'the carelessness about the remains of their dead relatives' is also predicable of many; 'the fact that the food consisted chiefly of reindeer' only proves that reindeer was an accessible and plentiful food, and by no means denotes community of origin. Mr. Dawkins' argument is:—All who eat reindeer meat are 'closely allied:' Esquimaux eat reindeer meat and Aquitanian cave-dwellers ate reindeer meat ∴ Esquimaux and Aquitanian cave-dwellers are 'closely allied.' At the present moment, English, Americans, Negroes, and Red Indians are feeding here on beef (when they can get it): yet there is no community of race. Mr. Dawkins' last statement regarding the small stature being 'proved in the people of the Dordogne Caverns by the small-handed dagger figured by Messrs. Lartet and Christy in the *Révue Archéologique*,' I must doubt. All who are acquainted with the small-griped swords of the existing Hindoos, and of many of the so-called Phœnician sepultures, will know that they are held in the hand in a very different way to that of our own swords, and that the smallness of the grip by no means connotes the size of the individual."

Man in the days of Eozoon.—This startling proposition would appear to receive the sympathy if not the support of an Hibernian Geologist, Mr. G. Henry Kinahan, who, in a letter recently published, makes this allusion to the point: "The Biblical record may be sneered at because human remains have not been found except among the most recent of the tertiary deposits. However, in answer to this I may be allowed to put forward Col. Greenwood's suggestion; that *there is only negative evidence against the existence of man and the other land animals from the earliest periods of the earth*; for, to quote that author's words:—'Where are the fossil remains of *land quadrupeds* found? In cavern deposits, in drift and alluvium "deposited on dry land," in filled-up lakes, in bogs, or frozen up in polar regions. Now all these land museums are not only modern, but they are superficial and temporary. They are liable to be washed into the sea; and their fossil contents *must be* destroyed before they can be redeposited in marine strata.'" (Vide *Geological Magazine*, January.)

Explanation of the poverty of a Geological Fauna.—Mr. Thomas Belt, in a paper in the *Geological Magazine* (January) on the Fauna of the Lingula Flags, endeavours to account for the barren state of the Maentwrog epoch. He thinks that the poverty of the fauna cannot be due to its proximity to the beginning of life in our globe, for older rocks contain a varied fauna.

Nor could the conditions of sea-bottom have had anything to do with it, for its deposits show that the depth of the sea-bed must have varied much from time to time. The blue beds of the Maentwrog strata do not differ lithologically from the blue beds of the Menevian group. Hence he asks, Might there not have been in these ancient epochs great oscillations of climate such as we have certain proofs of in more recent times? Was it, he asks, the advent of a cold pluvia that drove southwards the Lower Cambrian fauna, with the exception of a few modified forms fitted to thrive in a more vigorous climate; and was it the return of a warm climate in the Tremadoc period that brought back the ancient types of life more or less changed? Mr. Belt is notorious for his interesting and philosophical speculations, and this last is not less remarkable than many which have preceded it.

Fossil Corals of the West Indies.—In a paper read before the Geological Society of London (December 4), Dr. P. Martin Duncan concluded his series of memoirs on the above subject by giving a description of the Miocene corals from St. Croix, Trinidad, and by offering some supplementary observations on the species described in the former papers. He also gave a complete and revised list of all the fossil corals he had described from the West Indies, including five species from the cretaceous strata; four species and one variety from Eocene deposits; and one hundred and two species and twenty-six varieties from the Miocene formation, making a total of one hundred and eleven species and twenty-seven varieties. Of the Miocene species eleven still exist, namely, six in the Caribbean Sea only, three common to that sea and the Pacific Ocean, and two in the Pacific Ocean and Red Sea, but not in the Caribbean. Twelve other species are common to European deposits and the West Indian Miocene, ten being of the same age in both hemispheres, while two occur in the lower chalk in Europe. These twenty-three species being deducted from those of the West Indian Miocene, a large characteristic fauna still remains; and Dr. Duncan showed that the recent representatives of the characteristic genera composing it are for the most part inhabitants of the Pacific and Indian Ocean, the Red Sea, and the Australian waters, and that their tertiary congeners are found in Europe, Australia, Java, and Sinde. Of the fourteen genera thus enumerated, eight are not represented in the recent coral fauna of the Caribbean Sea.

Volcanic Eruption in Nicaragua.—At the meeting of the French Academy, March 9, M. Ramon de la Sagra gave an account of the eruption of a volcano in Central America, which occurred in last December. The volcano was elevated in the middle of a plain, and continued to discharge lava for sixteen days. An enormous mass of mud and dust was thrown up, and formed a cone of seventy mètres high, and covered an area of some miles. The flames rose thirty mètres above the cone, and were seen from an immense distance at sea.

The Eruption of Vesuvius.—For a detailed account of the eruption of Vesuvius, which began on November 12, and is even yet hardly over, we cannot do better than refer our readers to a long paper which appears in *L'Institut*, March 4, 1868.

Earthquakes in the Cephalonian Islands.—M. Fouqué has published a description of the earthquakes which occurred lately in these islands, and whose phenomena he himself experienced. He has noticed one interesting

fact, viz.: that a closely defined line separated the parts in which the earthquake was felt from those in which no shock was experienced. This line corresponds exactly to the strike of the metamorphic limestone.—Vide *Compte Rendus*, February 17.

Remains of Early Man in Belgian Caverns.—In a memoir laid before the Royal Academy of Belgium, M. Dupont has given a description of the bones and carved and sculptured objects discovered by him in the cavern of the Lesse known by the name of Trou-Magryte. The bones found were those of *Elephas primigenius*; *Rhinoceros tichorimus, Cerus elaphus*, ox, chamois, marmot, various species of *Ursus, Hyæna spelæa*; *Felis Engiholiensis*; the wolf, the fox, and the reindeer.—Vide *L'Institut*, February 5.

The Erratic Phenomena of the Valley of Argelez and the Confluent Valley is the title of a paper read before the Académie des Sciences, by MM. Ch. Martins and Ed. Collomb. The authors attribute the character of the valleys to the existence of ancient glaciers. In this they differ from M. Elie de Beaumont. The paper is full of interest to the geologist.—Vide *Comptes Rendus*, January 20.

A Fossil Parrot, which was found in the island of Rodrigues, has been carefully examined by M. Milne Edwards, who states that the species resembles the *Psittacus Erythacus* of West Africa, the *Poiocephalus robustus* of the Cape of Good Hope, and the *Mascarinus vasa* of Madagascar. It has, however, structural peculiarities which separate it from them. M. Milne Edwards forms it into a new species.

British Fossil Cycads.—Mr. W. Carruthers, being engaged in investigating the structure of these fossils, would be obliged for information respecting specimens from any British locality which would enable him better to prosecute his inquiries. He reserves the examination of the foliage to a future period, confining himself for the present to the stems and fruits. Communications may be addressed to him at the British Museum.

Mammalian Remains at Ilford.—Mr. A. Brady has at much expense saved from destruction some fine remains recently discovered by workmen at Hill's Pit, Ilford. The remains included two fine pairs of horn-cores of *Bos primigenius*, a fine antler of *Cervus Elaphus* (with eight prongs), and a grand tusk of *Elephas primigenius*, measuring nine feet six inches in length. Large numbers of loose limb-bones and vertebræ of *Bos*, and bones of *Ursus* and *Equus*, were also obtained.

British Graptolites.—Those who wish to study this group of fossil Hydrozoa in all their relations should consult Mr. Carruthers' admirable memoirs in the *Geological Magazine* (February and March). The author has taken up the terminology given in Huxley's monograph on the *Oceanic Hydrozoa* (Ray Society), and has applied it to the fossil Graptolites, and thus he has given a philosophical character to his descriptions which cannot fail to render his investigations of great interest to both the geologist and the student of Natural History.

A new Section of Cambrian Rocks at Llanberis has been communicated to the *Geological Magazine* for March, by Mr. George Maw. He especially describes the Welsh greenstones, and publishes the result of a determination of their chemical constitution made at his request by Professor Voelcker. The following are the results of this analysis:—

Analysis of Greenstone Dyke, Penrhyn Quarries.

Water of Combination	1·99
Bisulphide of Iron	0·23
Protoxide of Iron	10·22
Peroxide of Iron	1·07
Titanic Acid	2·51
Alumina	5·80
Sulphate of Lime	0·08
*Carbonate of Lime	14·85
*Carbonate of Magnesia	14·59
Potash	0·43
Soda	0·70
Silica	47·47
	100·633

Chemical Geology in the Formation of the Earth.—In chemical geology, the discussion between Dr. Sterry Hunt and Mr. D. Forbes is doing good, by directing attention to this interesting branch of the science. Some of the questions at issue are necessarily so theoretical as not to admit of direct proof, and consequently allow of great latitude of opinion. Thus whilst Dr. Hunt insists upon the earth being solid to the core; that its surface immediately before complete solidification was covered by a shallow sea of molten matter, surrounded by an intensely acid atmosphere, containing hydrochloric and sulphurous acids; and that the saltness of the sea was due to the action of a rain of hydrochloric acid deluging the half-cooled crust—Mr. Forbes contends that the surface of the globe was not the last to solidify; that it still contains some reservoir of fluid igneous matter, from which volcanic lavas proceed; that the primeval atmosphere differed mainly from the present in containing much less oxygen along with a great excess of carbonic acid and steam; and that the sea was salt from the beginning owing to the water when condensed on to the earth dissolving the salt and other chlorides, &c., in its external crust. In this discussion, however, other problems of great importance, and capable of being ultimately solved by experimental and field observations are considered, as for example, amongst others, whilst Dr. Hunt, in all cases, regards granite as a sedimentary rock, and quartz as an aqueous product, Mr. Forbes shows that analogous rocks containing quartz are lavas from active volcanoes, and consequently in such cases must be igneous. He disputes Dr. Hunt's theories of the origin of limestone, dolomite, and gypsum, contending that most limestones are formed by organic life assimilating the compounds of lime in the sea, and not precipitates thrown down by carbonate of soda, and points out that all the magnesian limestones and gypsum beds could not, as Dr. Hunt advances, have been formed in a dense atmosphere of carbonic acid, since the greatest development of such strata occurred at a period when animals existed upon the face of the globe, which could not have lived in such an atmosphere.

* The carbonate of lime (and magnesia?) occurs for the greater part in the shape of separate crystals, which are visible in a fresh fracture to the naked eye, and effervesce in isolated spots on the application of hydrochloric acid.

MECHANICAL SCIENCE.

Supporting Power of Piles.—An extremely interesting communication on the supporting power of wooden piles, and on the mode of sinking cylinder foundations, has been sent by Mr. McAlpine, C.E. of New York, to the Institute of Civil Engineers. In forming the government graving dock at Brooklyn, some 6,539 piles were sunk to an average depth of 32 feet. The piles were on the average 7 in. diameter at the smaller, and 14 in. at the larger end. Most of them were driven by a piling engine, the head of which weighed 2,200 lbs. and fell 30 feet. The distance through which the pile was driven varied uniformly from 8 in. at the beginning to nothing at the end of the operation. With a Nasmyth piling engine, the head of which weighed three tons, the fall being 3 ft., the strokes 60 to 80 per minute, the same piles were driven 35 ft. in 7 minutes, whilst with the other machines they required an hour or more to drive them the same distance. Experiments were made on the supporting power of the piles driven by the ordinary piling engines to the point at which they ceased to give under the blows of the one ton ram. It was found that they required 125 tons of statical load to cause them to move. Mr. McAlpine has given a formula founded on this result, which, however, appears to be of too empirical a character to be of much service. The mode of sinking cylinder foundations, similar to those employed at Rochester Bridge and at the Thames bridges, is also described, and Mr. McAlpine states that he found the ultimate supporting power due to friction of these cylinders, when sunk 20 to 30 ft. in moderately fine gravel, to be half a ton per square foot of external surface. According to M. Gaertner, however, the supporting power of such cylinders does not exceed 300 lbs. per square foot of external surface.

Removing Mountains.—Under this title the great cutting on the proposed ship canal in Western Canada is described in *Engineering*. This cutting is 8½ miles long, with an average depth of 80 ft., a maximum depth of 198 ft., and will require the removal of 36,000,000 cubic yards of material, or 18 times as much as the two mile cutting of the London and North Western Railway at Tring. At the rate of half a million cubic yards annually, which is about as much as has been excavated in this country, this cutting would require 72 years for its completion. Recourse is therefore proposed to the steam excavator, capable of removing 1000 yards per day. In the paper from which we quote it is suggested to turn the site of the cutting into a reservoir or lake, and dredge out the material, as the cheapest and most rapid means of effecting its removal. The steam excavator or steam shovelling machine, although nearly unknown in this country, has been extensively used in America, where manual labour is costly and scarce. It is capable of removing about 1000 to 1200 cubic yards in the twenty-four hours.

Steel Rails.—In December, a steel rail on the Charing Cross Bridge broke during the passage of a train, without however causing any mishap. The rail had been rolled in 1864, and was a flat-footed rail weighing 70 lbs. to the yard. A piece of the top table of the rail, 20 in. long, was detached by a fracture extending downwards and longitudinally to the end of the rail,

and passing through two bolt holes. The rail, when subsequently tested, was broken by 9 falls of a weight of 300 lbs. from heights increasing from 5 to 13 ft. The material proved to be of too hard a character to be suitable for rails, a fault not unfrequently occurring in the earlier made steel rails. Notwithstanding this, the use of steel for rails is making most steady progress, and their powers of endurance when once laid appear to be most remarkable. In several instances they have outlasted 8, 12, 16, and in one instance 22 faces of iron rails without wearing out, a result due partly to their greater strength and hardness, and partly to the fact of their greater homogeneousness and the absence of those planes of weakness present in all welded bars.

The Monitor Question.—A somewhat warm discussion has arisen as to the strength of armour-plating on the American monitors. Mr. Bourne has now admitted that he was in error, and that the drawing of the armour-plating of the 'Dictator,' given by Mr. Reed to the Institution of Civil Engineers, and published in the last volume of their proceedings, is correct. The armour-plating diminishes in thickness, in steps from the water-line to the bottom of the armour shelf, so that these vessels do not carry quite so much armour as has been commonly supposed.

War Material.—We may call attention to some very interesting papers on war material, contributed by a well-known and accomplished authority on artillery, to the pages of the *Engineer*. They contain an account of the most recent improvements in the electro-chronometric instruments for measuring the velocities of shot, particularly those of Professor Bashforth and of Captain Schultze; also some interesting details of the best forms of torpedoes, and of the manner of using them; and a discussion of the principle of muzzle-pivoting which was proposed in 1856 by Mr. R. Mallet. Muzzle-pivoting consists in the arrangement of the racers and slides, and of the gun-carriage, so as to enable all the movements of the piece, necessary to aiming at an object, to be effected in the same manner as if the gun itself were moved about a point situated at the muzzle, and in the axis of the piece. The result is that the gun so mounted can be directed and fired through a round aperture or embrasure very little bigger than the muzzle of the gun itself. The importance of such an arrangement at the present time will be evident.

Gibraltar Shields.—The Government having constructed some armour-plated shields, for Gibraltar and other places, one of which under fire proved disastrously weak, have reappointed the Armour-Plate Committee, which did such good service some years since in investigating the application of iron for purposes of defence, to undertake further experiments on the same subject.

Steel Ropes.—Messrs. Howell and Co. of Sheffield, have proposed the use of laminæ or ribbons of steel, which they can roll in any length, in place of wire for the ropes of suspension bridges. A specimen of this laminated rope, consisting of 48 laminæ, 3 in. wide and $\frac{1}{16}$ thick, would, according to their statement, require 720 tons to break it, and would not take any permanent set with less than 30 tons per sq. inch. It would be easy to place each strip over the space to be crossed by the bridge, laying the strips carefully on each other, and when the required section is attained, binding them together with

wire or with clips to prevent moisture entering between them. Such a rope would be stronger, and much more easily erected, than one of wire with the wires parallel over the span. And it would be much more rigid than a wire rope of twisted strands, and probably also more durable from its greater compactness.—*Engineering*, Feb. 1868.

MEDICAL SCIENCE.

Experiments on Animals with Soluble Silicates.—Herr Schwann, the celebrated author of the cell theory of development, has laid before the Belgian Academy of Sciences a paper of M. Husson's on this subject. The results of the author's experiments throw some light on the important question: Why are certain substances, when introduced into the body, found to be subsequently deposited in particular organs only? M. Husson administered alkaline silicates to dogs, and afterwards sought them in the several tissues. What was the result? He found only traces of them in the blood; they were absent from the brain, the bones, the liver, and the bile. The muscles, however, and the spleen contained deposited silica in considerable quantity, and the greatest quantity was found as a deposit in the urine. M. Husson's explanation may be correct—at all events it is interesting. He says that the silicates travelled along freely through the tissues till in the muscles the lactic acid developed during contraction precipitated the silica, and thus prevented its further removal. In the urine it was precipitated by the biphosphate of lime. The deposit in the spleen is, he confesses, beyond his power of explanation.—Vide "The Microscope Scalpel and Balance," in *Medical Times* for February.

The Structure of the Red Corpuscle has been investigated by Herr Brücke in a paper read before the Vienna Academy of Sciences. According to this physiologist, the corpuscle is composed of two substances—a soft and spongy material which he terms the *œcoid*, and an enclosed structure endowed with vitality, and which he styles the zooid. This latter is, he says, made up of two parts—1st, a central part which corresponds to the nucleus; and 2nd, a peripheral part, which extends into the interstices of the *œcoid* and binds all the structures together. His researches have been confined to nucleated blood-globules.—Vide *L'Institut*, December 26.

Chemistry of Mineral Springs.—The mineral waters of Austria—especially the three springs of Ebriach, Ursprung, and Sztojka—have received attention from Herr Redtenbacher, who has lately submitted them to analysis. The waters of the first are remarkable for carbonates and carbonic acid, those of the second for sulphur compounds, and those of the third for the large proportion of potash they contain. .

The Development of Tendons.—A paper which has been published by Herr Obersteiner on the development of tendons shows us negatively the advantage of such a record as that we have begun. This physiologist has presented a memoir to the Academy of Vienna, in which, so far as we can see, he only repeats what is stated in many books, and which is strongly asserted by Virchow, viz. that the fibres of tendon (*i.e.* the elastic or yellow

fibres) result from the processes of the cells, or connective-tissue corpuscles, as the Germans term them.

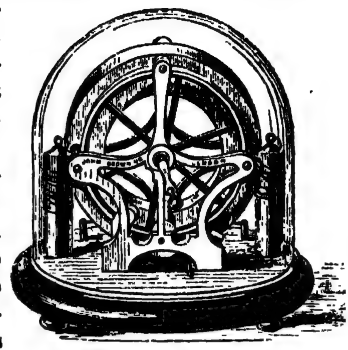
The Vaso-motor Nerves of the Brain.—The opinions long since formulated by Bernard and the French physiologists regarding the action of the vaso-motor nerves of the brain have received confirmation in a paper recently published in Virchow's *Archiv* (Band 41, 1867) by Herr Nothnägel. The experiments of this observer were conducted on rabbits which had not been narcotized, and are therefore especially worthy of notice, as being less liable to error than many of the experiments recorded from time to time. In the course of his investigations, Herr Nothnägel found that the vessels of the pia mater dilated after simple section of the trunk of the cervical sympathetic, and frequently contracted after the excitation of the distal end of the divided nerve by electricity. The vessels of the pia mater also contracted after the application of electricity to the superior cervical ganglion; but were dilated after the removal of this ganglion. Irritation of the senses, after the division of both sympathetic nerves, or the removal of the superior ganglia on both sides, caused contraction of the vessels of the pia mater. To account for this last result, it is supposed that some of the vaso-motor filaments are supplied by the cranial nerves which anastomose with the carotid plexus in its course through the carotid canal: these nerves are, the motores oculorum, the trigeminal nerves, the abducent, the glosso-pharyngeal, and the vagi.

Pathology of the Skin.—Herr Biesadecki has presented a memoir to the Vienna Academy on this subject, in which, after dealing with the healthy structure, he treats of the conditions of growth in various inflammations. Phlegmonous or erysipelatous inflammations are not simply the result of an exudation, but are also connected with a new formation of cells in the true skin and in the subcutaneous cellular tissue; the alteration of the walls of the vessels is a secondary process. Syphilitic induration of the prepuce is also accompanied by increased cell growth; a decided multiplication of the nuclei in the walls of the vessels may also be seen: these nuclei, he thinks, ultimately block up the blood-vessels, and thus cause desquamation. The same may be said of syphilitic spots. Condyloma would seem to be associated with a similar development of cells. In the production of eczematous vesicles the process is different. Here the cells originate from the deep skin, but they soon pass into the mucous layer of the cuticle, and by their division they separate the two layers (scaly and mucous) of the cuticle, and in this way produce a conical pustule.—*Medical Times*, February 1.

Phosphorized Chloroform.—The French correspondent of the *Medical Times and Gazette* directs attention to the efforts made by M. Beaumetz to introduce phosphorus into therapeutics. Phosphorus has been objected to because of the digestive disturbances it produces; but M. Beaumetz states that the objections are due, not to the agent itself, but to the preparations hitherto employed. He therefore proposes a new vehicle for this substance, viz. chloroform. The solution prepared contained $\frac{1}{1000}$th of solid phosphorus. It is administered in capsules of gelatine (highly coloured in order to avoid the decomposing action of light), and containing each one gramme of the liquid, a quantity equivalent to one milligramme of phosphorus. It is, therefore, easy to calculate how much the patient is taking, since each

crystal corresponds to a definite unit. Dr. Beaumetz has already employed this preparation with success in various cases, especially in locomotor ataxy.

A new Medical Magneto-electric Machine, which we have much pleasure in recommending to the notice of our medical readers, has been constructed by Mr. John Browning, philosophical instrument maker, Minories, E.C. The objection to the use of this form of induction coil hitherto has been the fact that the currents are rapidly and constantly, if we may use the expression, reversed. This difficulty has been overcome in the apparatus represented in the adjoining cut by the employment of an ingenious commutator, which, as the wheel revolves, transmits all the positive currents along one pole, and all the negative ones along another. Thus this machine, while free from the smell, liability to accidents, injury from corrosive acids, &c., so common in the volatile induction coil, has all the advantages of this instrument; and while it forms an ornamental appendage to the consulting room, it is always ready for use by the practitioner.



Improvements in Carbolic Acid.—Mr. Grace Calvert, who has done so much to improve the carbolic acid of commerce, and to cheapen this substance by simplifying the processes for its preparation, made the following remarks in the course of a lecture delivered before the French Society for the Encouragement of National Industry. Having described his many efforts to induce the profession to employ carbolic acid, he went on to say: "But the tarry and sulphuretted odour which it still possessed was a serious obstacle to its application. I soon succeeded in overcoming this difficulty, and towards the end of the year 1864 our firm was in a position to deliver, in considerable quantities, carbolic acid deprived of sulphuretted compounds, and therefore fit for all medicinal uses. But I am glad to say that the series of improvements in the manufacture of pure carbolic acid, or phenic alcohol, did not stop there, for towards the end of last year I discovered a process which now enables me to show you a product completely deprived of all disagreeable odour and tarry flavour, and, in fact, as pure, though extracted from tar, as if it had been produced artificially by the help of the reactions recently discovered by Mesrs. Wurtz and Kékulé, based upon the direct transformation of benzine into carbolic acid, or by the well-known changes by which it may be obtained from salicylic acid or nitro-benzoic. This new phenic or carbolic acid is distinguished from Laurent's in being soluble in 20 parts of water, whereas the latter requires 33. It is fusible at 41°, instead of 34°, and boils at 182°, instead of 186°, but it gives, like Laurent's, the blue colour described by M. Berthelot when mixed with ammonia, and to the solution is added a small quantity of a hypochlorite. The same effect is also produced when you expose to the vapours of hydrochloric acid a chip of deal soaked in this pure carbolic acid.

Respiration in Cattle.—M. Reisét's researches on this subject are of interest, since the experiments were conducted on a large scale, his receivers,

&c., being sufficiently large to enable him to submit the entire exhalations of full-grown sheep and calves to examination. During the respiration of calves and sheep, he found a considerable quantity of carburetted hydrogen in the gaseous mixture. This, too, is under the normal conditions. Calves in some experiments were fed upon milk only; deprived thus of vegetable food, the gaseous mixture exhaled resembled more nearly in its composition that exhaled by the carnivori. The production of carburetted hydrogen became absolutely *nil*. M. Reiset considers the formation of carburetted hydrogen in the stomachs of ruminants, when upon their natural food, to be a phenomenon of incomplete combustion. He deduces from these and former researches, the general conclusion, that the respiratory products depend much more upon the nature of the food than upon the species of the animal.

Relation of Health to Geology.—The following letter, addressed by Mr. J. Bray to the editor of the *Chemical News*, and published in that journal (Jan. 10th), is so significant, that we print it in full for the consideration of our medical readers:—"In the report of the meeting of the Local Board of Health of Sheerness the following paragraph appears:—'The surveyor said that Dr. Buchanan, from the office of the Privy Council, waited upon him to make inquiries respecting the nature of the soil at Sheerness. By permission of Messrs. Ward and Brightman he had shown the gentleman the different strata forming the soil of Sheerness. Dr. Buchanan has now stated that after a careful examination he is convinced that in Sheerness there are fewer cases of consumption than in any town in England, and as a whole that Sheerness is one of the most healthy places in the kingdom.' If I read correctly, it seems that the healthiness of a place is dependent somewhat on the strata of the locality. Can you, or any of your readers, give me any information or the name of any work in which the subject is treated on? Ague is very prevalent here, and two medical gentlemen inform me that they always endeavour to remove, as soon as possible, all consumptive persons from Sheerness, which perhaps to a certain extent may account for the few cases of consumption mentioned by the authority in question as found in Sheerness."

Preservation of Syrup of Iodide of Iron.—At the meeting of the Pharmaceutical Society, Feb. 5th, Dr. Attfield read a paper by Mr. T. B. Groves, in which the author stated that he had for some time been experimenting on the best modes of preserving the syrup. He had found that it kept better when made with iron filings instead of pure iron in the form of wire, which he attributed to the presence of impurities in the filings. He had added dilute sulphuric and phosphoric acids as preservative agents, and had obtained successful results with them. Mr. Groves prepared a number of specimens of the syrup, and to one he added 1 minim of dilute sulphuric acid to the oz.; to another 2 minims of dilute phosphoric acid to the oz.; to a third, 2 minims of dilute phosphoric and 1 minim of dilute sulphuric acid to the oz; and to another specimen 8 drops of phosphoric acid. He had found that phosphoric acid was the only acid to be relied on, and it was very necessary not to add the acid before the syrup had cooled.

Recurrent Sensibility in a Divided Nerve.—The *British Medical Journal* reports a case which was recently brought before the Medical Society of Strasbourg by M. Bœckel, and in which there was recurrent sensibility of a

divided median nerve—the result of accident. Immediately after the accident, it was ascertained that the fingers had not lost all sensibility, and the central end of the median nerve was sensitive. The superficial and deep flexor tendons were completely divided, as well as the nerve. The fingers and wrist were flexed during three weeks. The nerve was not sutured. At the end of two months, the movements were restored, and sensibility was normal over the whole palmar face of the hand and fingers, except the index, where it was blunted. According to M. Bœckel, the regeneration of the median nerve is the more rapid for the absence of any suture.

The Capillaries in Cerebral Softening.—In the *Archives Générales de Médecine* for January, MM. Prevost and Cotard have published the results of some researches which, they think, demonstrate the following proposition: That, if granulo-fatty degeneration of the capillaries and their aneurismal dilatation may, in a certain number of cases, be considered as the primary lesion which acts as the producing cause of softening of the brain, these same vascular alterations may be secondary, and depend, like the concomitant alteration of the nerve-tissue, for instance, on arterial obliteration. They appear, also, to be capable of secondary production, whatever may be the producing cause of the necrobiosis of the nerve-tissue.

Temperature of the body in Convulsions.—MM. Charcot and Bouchard publish, in the journal above quoted, a valuable paper on the temperature of the body in convulsions. They have discovered a remarkable difference between the internal temperature accompanying tonic and that found in cases of clonic convulsions. In all forms of tonic convulsions, whether produced by disease or electricity, the internal temperature is virtually increased; in clonic convulsions, on the contrary, it is not perceptibly altered.

Deposit of Uric Acid.—Physiologists and physicians are both interested in knowing why it is that uric acid is deposited in the urine; and we therefore refer them to a paper read by Herr F. Hofmann before the Royal Academy of Munich, as containing all the information required. Herr Hofmann takes up the theories of his predecessor in this inquiry, and he very satisfactorily disproves them. He then proceeds to show that, as proved by Liebig, the acidity of urine is due to the presence of acid phosphate of soda; and he shows that, if this salt and one of the urates be mixed in solution in equal proportions, the mixture will become alkaline, the urate will be decomposed, and uric acid will be deposited. Then he points out that the uric acid in urine is deposited subsequently to, and not on, cooling the secretion; and that, while it is being deposited, the urine is becoming alkaline. He therefore concludes that uric acid is derived from the urates which are decomposed by the acid phosphates of soda.—Vide *L'Institut, March* 11.

METALLURGY, MINERALOGY, AND MINING.

The Coal-fields of Scotland.—In one of the late numbers of the *Artizan*, a very interesting account is published of the coal-fields of Scotland, from which we learn that, though fragmentary beds occur in the Western Islands, the great coal-strata extend along the valleys of the Forth and Clyde, and

occupy an area of about one-seventeenth of the whole of Scotland. The uppermost of the coal strata is found at Fisherrow, and between it and the old red sandstone, which forms the floor of the coal formation, there are 337 alternations of strata, having a thickness in the aggregate of 5,000 feet. In the thickest part there are 62 seams of coal, counting the double seams as one, and about one-half of these are workable. The depth of strata at Musselburgh is, however, exceptional; and the average depth is estimated to be about 3,000 feet, of which the coal-seams occupy 126 feet. The thickest bed of coal in the Lothian field is 13 feet; but at Johnstone, in Renfrewshire, there is a seam of 100 feet in thickness. This latter owes its extraordinary bulk to the overlapping of the coal strata during some great convulsion in the locality. The most important of the coal-fields is the Clydesdale, on which one-half of the entire number of collieries in Scotland are situated. Thirteen counties lie over or touch upon the coal-fields, and of these Lanarkshire has by far the largest share of the store. Judging from the number of collieries possessed by each, Ayrshire, Fifeshire, and Stirlingshire, come next in order. In nearly all the counties, more or less valuable beds of ironstone, shale, and limestone, are intermixed with the coal. The Scotch cannel or parrot coals are very valuable on account of the high proportion of gas and oil which they yield. The Boghead variety gives 120 gallons of crude burning oil, or 15,000 cubic feet of gas per ton; and the brown Methil 90 gallons of oil, or 10,000 cubic feet of gas per ton. In the Edinburgh Industrial Museum, there is a collection of specimens of the different kinds of coal found in Scotland and elsewhere, together with the tools used in mining. The cannel coal found at Wemyss, Fifeshire, is carved into various articles of a useful and ornamental character—such as picture-frames, inkstands, brooches, &c.—and a table formed of it is exhibited in the museum.—Vide the *Artizan*, February.

The Distribution of Gold.—A newly published American journal takes up for examination some of the popular beliefs regarding the distribution of gold as a mineral, and corrects the erroneous supposition that gold-bearing veins diminish in value with increasing depth. It alleges that it is established that lodes bearing gold at the surface contain gold at every known depth, that the value of it frequently remains the same, and more frequently increases than diminishes, that lastly, the gold in the majority of lodes is diffused according to simple laws, while the ores which contain it are in the forms of extended columns.—Vide the *Mining Gazette*, Vol. I., No. 2.

The Formation of Mineral Veins.—Professor Wurtz has published a paper recently read by him before the *American Association for the Advancement of Science*, in which he urges the following conclusions:—First. The contents of the primary metalliferous strata, as well as the lodes therein contained (both ore and gangue) were deposited from suspension and solution in the hot water of the primeval ocean. Second. These waters contained *on all the metals*, in forms soluble, if not in pure water, yet in solutions of some one or other of the saline constituents of the ocean. Third. The metals now found in these rocks as *sulphides*, must have existed in the waters of that ancient ocean as *sulphates*, or certainly associated with enough of the sulphates of other bases (alkalic and earthy) to furnish the sulphur now extant in the sulphides. Fourth. Through some great and all-

pervading reducing agency, doubtless that of *carbon* of dead organisms—which had lived probably to some extent even in the concentrated brines of the ocean, but chiefly in cooler and more dilute waters along and near its coasts, formed by the influx of continual torrents proceeding from a constant, universal, and enormous condensation upon the mountain heights and slopes—the metallic sulphates become sulphides, and were as such deposited in admixture with the sediments and precipitates (whether mechanical or crystalline, or both) of the oceanic waters. Fifth. The carbon doing this work passed back in the act into the atmosphere as carbonic acid, to be again taken up by vegetable organisms;—or, by condensing as aqueous solution on the mountain slopes, to be converted into calcic bicarbonate by contact with calciferous silicates, and flow back in this form to the ocean, to be there itself converted sooner or later into sediments, by both chemical and vital influences; thus the carbon performing alternately its several allotted functions, till finally locked up in the forms of calcite, dolomite, chalybite, graphites, coal, petroleum, asphalts, and other resinoid substances.

Reeve's Patent Gun-Felt.—This compound, which has been patented by Mr. F. W. Reeves, is intended to be used as a substitute for gunpowder, for military, sporting, and mining purposes. Its physical and mechanical properties are intermediate between those of gunpowder and gun-cotton. This substance is derived from cotton rags which, after being torn to fibres, are rendered somewhat explosive after the manner of gun-cotton, are subsequently made more explosive by the addition of other ingredients, and thus a uniformity is obtained which, according to the inventor, cannot be relied on with pure explosive fibre such as gun-cotton. It is used in a pure state, and by bulk is as explosive as gunpowder, and a charge generates a greater volume of gas; a charge of gun-felt weighing 1 dram being fired in a shot-gun with No. 6 shot, will at a range of 40 yards penetrate 28 sheets of brown paper, to cause this effect it requires at least 3 drams of the best gunpowder, and as at the moment of ignition the reaction is not so sudden as with gunpowder, most of its explosive force being applied when the projectile has overcome the greater part of its inertia, the recoil of the gun is not so great, being about 50 lbs. with gun-felt to 67 lbs. with gunpowder. This material is said to be used in rifles with good effect, and to be cheaper, cleaner, and safer in use, and, finally, is productive of little recoil or smoke.

Two New Minerals.—Herr Hagemann has discovered two minerals accompanying cryolite, and has termed them *dimetric pachnolite* and *Arksutite*. The first resembles the pachnolite described by M. Knoss; it occurs in prisms or in quadrangular pyramids, cleaveable in the direction of the base, of a pinkish white colour and very brilliant. Its density is from 2·74 to 2·76, and its hardness the same as cryolite. Sulphuric acid easily attacks it. The specimen analysed contained 2 per cent. of silica, which M. Hagemann considers foreign to the composition of the mineral, to which he assigns the formula, $Al_2Fl_3+2(\frac{2}{3}Ca+\frac{1}{3}Na)Fl+2HO$. *Arksutite* is granular, white, and crystalline, and, like the other mineral, very brilliant. Its density is from 3·03 to 3·17; its hardness is equal to cryolite. At a dull red heat it fuses, without loss of water. Analysis gave numbers corresponding to the formula $2(Ca_2Na)+Fl+Al_2Fl_3$. These two minerals occur at Arksut-Fiord, in

South Greenland, and are probably the result of the decomposition of cryolite.—Vide *Chemical News*, January 3.

The Amount of Gold in the World.—The entire amount of gold in the world at the present time is estimated at about \$5,950,000,000 in value. If melted together it would make a lump of 660 cubic yards. If beaten out into gold-leaf it would cover an area of about ten thousand square miles, a tract one hundred miles square, less than the extent of Vermont, and little more than a fifth of either New York or Pennsylvania.—*Halifax Mining Gazette*, February, 1868.

How to Coat Iron with Copper.—Our contemporary the *Illustrated London News* gives from week to week a *résumé* of the progress made in scientific discovery, and this is done with so much ability and discrimination that we do not scruple to quote from its pages the following statement in reference to the process above referred to: The surfaces, after having been well cleaned with a brush and with diluted muriatic acid, are steeped in water slightly acidulated. The articles are then placed in a bath composed of 25 grammes of oxide of copper, 176 grammes of muriatic acid, half a litre of alcohol, and quarter of a litre of water. The copper is equably deposited over the surfaces, the alcohol reducing the rapidity of deposition, and thus giving greater density to the copper film. These coppered objects may be zinced by placing them in a bath composed of 10 grammes of chloride of iron and one litre and a half of alcohol, and in contact with pieces of metallic zinc. A coating of antimony may be given to the coppered objects by mixing chloride of antimony with alcohol and adding muriatic acid until the mixture becomes clear. In this bath the objects may be left for three quarters of an hour. For silvering glass or vases four solutions are prepared, the first composed of 10 grammes of nitrate of silver in 100 grammes of water; the second, an aqueous solution of ammonia of 0·984 density; the third of 20 grammes of caustic soda in 500 grammes of water, and the fourth of 25 grammes of sugar in 200 grammes of water, to which is added a cubic centimetre of nitric acid and 50 centimetres of alcohol. Mix the three first solutions and then add the last, when the deposition of silver will take place.

Hungarian Minerals.—At a late meeting of the Academy of Science of Vienna, Herr M. G. Tschermak gave some details of certain minerals collected in the mines of Joachimstal in Bohemia, and Kremnitz in Hungary. On old specimens from the former, he says, there may be seen "decomposed mineral" of monoclinic crystalline form, and associated with Haidingerite and Pharmacolithe. This mineral, which has a formula of

$$2M_gO.HO.AsO_5.8HO$$

is in all probability Roesslerite, become opaque through loss of water. M. Paulinyi has recently found at Kremnitz beautiful crystals of Voltaite analogous in their chemical composition to artificial crystals of this substance obtained by M. Abich. The Kremnitz Voltaite is composed of two isomosptric combinations:

$$4FeO.Fe_2O_3.7SO_3.10HO$$
$$AlO.2Fe_2O_3.7SO_3.10HO$$

a small quantity of oxide of iron being in the second replaced by alumina.—Vide *L'Institut*, March 11.

Sulphur in the Smelting Districts.—The sulphurous smoke in the copper-smelting districts, such as Swansea, which formerly destroyed the surrounding vegetation and impaired the health of the people, is now turned to profitable account in the production of sulphur. Copper and iron pyrites contain from 40 to 50 per cent. of sulphur, and it is reckoned that sulphur of the value of half a million sterling may be annually obtained from sources heretofore not merely useless, but pernicious.

Bronzing by Aniline.—The aniline dyes have been used as a means of producing an artificial bronze. When employed in a concentrated solution, and painted in objects, they give a somewhat bronzed appearance.

The Supposed Dangers of Nitroglycerine.—"Give a dog a bad name and hang him," says the proverb. This is true enough in the case of the nitroglycerine subject. Because a few serious accidents have occurred, all sorts of absurd and imaginary evils and dangers are associated with this substance, and really most of the accidents have been caused by that extreme ignorance which is characteristic of some people, and which would lead to serious accidents with almost any new substance. Hear what Mr. Nobel, the inventor, has to say. He gives the following illustration:—"In five cases congealed nitroglycerine has been melted purposely over fire. In three cases a red-hot poker has been inserted into the oil in order to melt it. In one case a man took to greasing the wheels of his waggon with nitroglycerine, knowing what it was, and it went all right until it struck hard against something, and then the wheels went to pieces. In one case it was burnt in a lamp as an improvement on petroleum. In these days every mischief is charged to nitroglycerine. Thus we read in the *Northern Evening Express*, that recently a box with nitroglycerine exploded at a railway station in the city of Berlin, 'and that the simple act of placing it in the van caused it to explode.' It is a proved and confirmed fact that it was fulminate of mercury that exploded." Nitroglycerine, Mr. Nobel says, has been accused of spontaneous combustion, but the truth is that, unless properly purified, it emits a nitrous odour, and will gradually decompose during some years. The nitroglycerine, however, now made by him is always pure, he writes "chemically pure"; it is obtained by crystallisation from wood naphtha.—*Chemical News*, January 3.

Lead Floating on Molten Iron.—Experiments lately made in Germany seemed to show that molten lead, though really denser than iron, would nevertheless float on molten iron. Professor Kamarsch, however, put the matter to the test by examining a block of cast-iron, supposed to contain drops of lead lying upon the surface. Professor Kamarsch found, upon close examination, that these drops of lead, instead of being solid globules, as was supposed at first sight, were all found to be hollow, forming bubbles composed of metallic skin, and apparently empty in the centre, so far as his observation was carried. He explains the whole by supposing that the molten lead, at the temperature to which it is raised by the contact with the liquid iron, forms an incipient vapour of lead, which is prevented from escaping by the skin of solidifying metal which forms on the top. The lead vapour, according to this explanation, keeps the lead resting upon the surface of the iron. It seems that in large quantities the result is different, since it is known that lead is occasionally tapped from the bottom of the blast furnaces which smelt certain classes of ores containing lead, and in

these cases the lead is found below the liquid iron according to its greater specific gravity.—Vide *Chemical News*, January 24.

Extraction of Indium from Zinc.—A method for effecting this has been published by Herr Richter. The zinc is dissolved in sulphuric or hydrochloric acid, and the residue, which is composed of zinc, indium, and other metals, is treated with nitric acid. The solution is evaporated with sulphuric acid, diluted, and a current of sulphuretted hydrogen gas passed through. The indium is almost completely precipitated with the cadmium and copper. The precipitate is dissolved in hydrochloric acid, and precipitated by ammonia. By repeating the process several times the whole of the zinc and cadmium is separated. Finally, the small quantity of iron still mixed with the indium is removed by a partial precipitation with ammonia and carbonate of soda. Indium is obtained by reducing the oxide; this may be effected by heating in a current of hydrogen gas, or by the power of a voltaic battery.

Amber in Australia.—The *Ballarat Evening Post* states that amber has been found of good quality, and in considerable abundance, at Rokewood, near Ballarat.

Petroleum for Locomotives.—On one of the Pennsylvania railroads, an attempt was made to work an ordinary locomotive with petroleum instead of coal for fuel. The experiment was suspended only on account of the defectiveness of the mechanical appliances for the new fuel. A later trial was made on the Hudson River railroad; but in consequence of some blunder on the part of one of the operatives, the result was not as satisfactory as it might have been, although the indications were exceedingly favourable for a final success. An ordinary locomotive consumes, on an average, about one ton of coal in three hours, or its equivalent in wood. A vast saving in transportation of fuel will be made on the great continental road, in passing over those portions of the line destitute of wood or coal—a distance of about 800 miles—if oil is found an economical fuel for making steam. Experiments thus far tend to prove that a pound of oil will make as much steam as two pounds of coal.—Vide *The Artizan*, January.

MICROSCOPY.

Microscopic Crystals.—As doubtless many of our readers are interested in the examination of minute crystals under the microscope, it will be of interest to give a short account of some recent experiments on this subject, which were narrated in a paper lately read before the Pharmaceutical Society, by Mr. W. S. Waddington. Mr. Waddington gives good practical advice to those about to study "microscopic crystallography." He states that he has obtained better results by allowing the crystals to be deposited from a hot and concentrated solution, than by placing a few drops of a cold saturated solution on a clean slide, and allowing it to evaporate spontaneously. When crystals are pretty soluble in water, the way of procedure is as follows:—A solution is made in hot distilled water, the liquid filtered, and a few drops poured on to a clean slide just before the crystals begin to form

in the solution itself, and immediately poured off, sufficient will remain behind for the production of crystals, which will form at once. When of a sufficient size, the remaining liquor, if any, should be drained from them and the slide allowed to dry. The result will generally be a slide, evenly covered with crystals, having well-defined edges, and but few of which are agglomerated. This process answers well for alum, chlorate of potassium, nitrates of barium and strontium, potassio-tartrate of antimony, sulphate of copper, sulphate, acid tartrate, binoxalate, and quadroxalate of potassium, the strength being regulated by experience. If crystals are not very soluble in cold water, they may be allowed to separate in the bulk of the solution itself as it cools, then remove a small quantity of liquids and crystals to a slide by means of a glass tube. The slide must be kept moving to prevent the aggregation of the crystals, and the superfluous liquid removed by applying blotting paper to the edges of the slide.

A Microscopic Discovery.—Mr. George Henry Lewes, who, as our professional readers are aware, is an adept in the discovery if not in the development of physiological theories, and who employs the pages of the *Pall Mall Gazette* as the scientific (!) platform from which to ventilate what he is pleased to style his 'heresies,' has recently announced to the readers of that journal a discovery which he says he made when last in Germany, and which he thinks they should be informed of. This discovery is no less than that of the existence of a journal called *Schultze's Archiv*, for microscopical anatomy. As we have been in the habit for some years of quoting passages from this journal, and as our excellently conducted contemporary the *Quarterly Journal of Microscopical Science*, from time to time has published two or three lengthy translations from Schultze's journal, it certainly did strike us as somewhat singular that Mr. Lewes should thus suddenly wake up, like a second Rip Van Winkle, to a new enlightenment. It occurs to us, too, as not a little remarkable that a would-be *savant* like Mr. Lewes, who evidently desires to be thought *au courant* with the labours of scientific men, should—as appears on his own showing—have been ignorant of the fact that an English microscopical journal has an existence, 'local habitation, and a name,' and is in every way worthy of the high reputation of British histologists. Mr. Lewes might two years ago have seen the journal he has just discovered, lying on the table of the College of Surgeons. Like the astronomer in the story he has been seeing too far, and projecting the fly in his telescope upon the body of the sun. Mr. Lewes is, it seems, one of those scientific prophets whom an ungrateful country has failed to honour.

The Royal Microscopical Society.—The annual meeting of the Society was held in February, James Glaisher, Esq. F.R.S., in the chair, and the report showed that seventy-four new Fellows had been elected during the year, the total number being 451. The auditors' statement of accounts showed that the income of the society from all sources during the past year was 1,515*l.* 17*s.* 3*d.*, and the expenditure 1,274*l.* 2*s.* 11*d.*, leaving a cash balance in hand of 241*l.* 14*s.* 4*d.* It was also shown that the society possesses a large and valuable collection of microscopes and apparatus, a cabinet containing in all 2,674 slides, and a well-sected library, which, together with the famous machine for microscopic writing, are available for the use of the Fellows. The president, in delivering his address, warmly congratulated

the society upon its improved position, and severally reviewed the various matters which have been brought under the notice of the Fellows during the year.

A Gas Slide for Microscopical Work.—In the supplement to *Schultze's Archiv* (Bd. 3, Ht. 3), Herr Stricker describes a slide so constructed that currents of any gas may be introduced and allowed to operate on an object whilst under examination in the field of the microscope, and which may also be employed for the transmission of electric currents to the object. The following is an account of its construction, which the reader will better comprehend by referring to the *Microscopical Journal* for January. In the middle of a piece of thickish glass a circular groove is cut, and from this is channelled a straight furrow of the same depth to each end. In each of these furrows is placed a slender metallic tube, preferably of platinum, and each having at its extremity a small bulbous enlargement, for the purpose, when needed, of affixing caoutchouc tubes. These metallic tubes are cemented into the furrows by means of shellac or other suitable cement, and thus serve as the sole means of communication with the circular furrow. The whole surface of the glass is now covered either with a layer of paper or of some varnish, but in either case has a circular space left open in the centre. The object of the paper or other covering is to keep the covering glass at a suitable distance from the central circular portion of glass upon which the object to be examined is placed.

A Novel Microscope Lamp.—Mr. Charles Collins has shown us a contrivance, devised by Mr. Fiddian of Birmingham, and manufactured by him, which

LAMP WITH CHIMNEY ATTACHED.

CHIMNEY OF LAMP.

so entirely surpasses in efficiency everything we have before seen, that we must give a short account of it. It is a modification of the parabolic reflecting chimney recently constructed by Mr. Collins for the Bucket-lamp. It is simply a copper chimney expanding into a sphere below, as shown in the

cut, and having fitted into one portion of this sphere a plate of very thin glass. This chimney is lined with a fine layer of white plaster of Paris, and when placed upon the lamp no glass chimney is required. Its advantages are, firstly, that a stream of parallel rays of the whitest "white-cloud" light is thrown upon the mirror of the microscope. Secondly, that all light is cut off, save that which reaches the mirror, thus protecting the worker's eyes. Thirdly, that being of copper, there is no annoyance of broken chimneys. There are other peculiarities in this chimney which we have not yet noticed; one is, that by a process, which Mr. Collins has not yet made known, it is composed of one continuous piece of copper, without seam or union, and the other that the plaster of Paris, by absorbing the products of combustion, formed in low temperature by petroleum, enables the flame to be retained at a lower level than in ordinary lamps. We examined this new piece of accessory apparatus, and can speak most favourably of its qualities and usefulness.

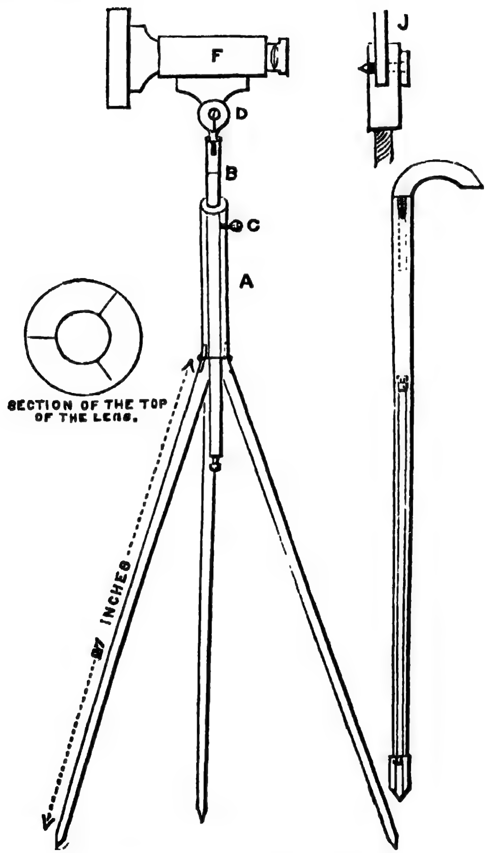
PHOTOGRAPHY.

Improvement in Dippers.—The third number of the *Illustrated Photographer* contains an improved form of glass dipper, devised by Mr. J. C. Leake, to avoid a very common source of failure arising from the nitrate solution being retained upon the tranverse ledge on the strip of glass forming the dipper. Mr. Leake thinks it probable, that when the coated plate is set into this little pool of silver-solution, a great part of the nitrate is at once abstracted by the iodides contained in the collodion; and as there is no solution to keep up the supply, wherever the weakened solution reaches the film, the cotton is precipitated, or the film is in some way altered in character, and opaque markings, radiating out all over the film from the bottom of the plate are produced. These annoying stains were, however, entirely got rid of by altering the dipper, and substituting for the ledge two square pieces of glass fastened on, as seen in the diagram.

Collodion Prints.—Much attention is being given to the process of printing from negatives on wet collodion in the copying camera, and afterwards transferring the films to plate paper. Prints so obtained are more delicate in detail and gradation, and more permanent, while they can be produced with considerable rapidity. The collodion used should give a strong film. The print is toned by mercury, and when mounted placed under a copper plate and rolled.

New Walking-Stick Tripod.—In our last Summary we described a new opera-glass pocket camera, devised by Mr. Sutton, and stated that a pocket tripod stand might be contrived for it. This has not yet been done; but in the third number of the *Illustrated Photographer*, a very ingeniously contrived walking-stick tripod, suitable for this camera, is described by J. S. We give a diagram of it. A is the top part of the stick, 1½ inch diameter and 9 inches long, with a hole through it ½ inch diameter; B is a rod ½ inch diameter, and 15 inches long, to go through the top part of the stick A, and 6 inches down into the legs of the tripod. The legs are hollowed in the

inside to receive it, and on the top of the rod is a brass ring about 1½ inch deep, in the top of which is a female screw, in which the jointed top is screwed that carries the camera. D is the brass top, with the joint J, and a screw to insert into the end of the rod, which can be heightened or lowered, and fixed by the screw G. F is a tube-line, with India-rubber to fit the opera-glass camera, for which a telescope might be substituted. When the tripod is used as a walking-stick, there is a stick-head with a screw attached to screw into the top of the rod, and a thin tube to hold the legs together



NEW WALKING-STICK TRIPOD.

at the bottom, where the diameter of the legs is ¾ inch. The whole is stained and varnished, and cannot, without a close inspection, be distinguished from an ordinary walking-stick.

Lunar Photography.—The *Mechanic's Magazine*, in an article on Mr. Warren de la Rue's lunar photographs, says: "In instantaneous photography the colour and composition of the glass forming the lenses affect the results, for all glasses are opaque, more or less, to a portion of the visible rays of the spectrum. The same difficulty besets photographic work with a reflecting

mirror, for the experiments of Professor W. Allen Miller, F.R.S., show that polished metals do not all reflect the extra violet rays so perfectly as they reflect the visible rays. For instance, he found that speculum metal and polished steel reflect exactly the same rays of the spectrum, and give spectra on a photographic plate of exactly the same length each. But he also found that speculum metal gave an intense image for one-half only of the length of its spectrum, whilst steel gave a more intense image than any other metal throughout the whole length of the spectrum of the light reflected from its surface. These results point to the conclusion, that a steel parabolic mirror will enable a photograph to be taken more rapidly than can be done by speculum metal or silvered glass reflectors. The *Mechanic's Magazine* also states that Mr. Dallmeyer is making a special enlarging lens for producing magnified copies without loss of details; but we think this must be a mistake, inasmuch as it is not superior defining power which is required, so much as superior films to enlarge upon, more free from structural defects; also the means of obtaining a much finer granular deposit of silver.

Enlargements by the Magic Lantern.—Mr. J. C. Leake has pointed out that with an ordinary magic lantern, and a quarter-plate, or carte-de-visite lens, the photographer has a most efficient enlarging apparatus, which, with a very thin fully developed transparency, and a lamp and reflector so arranged as to equalise the illumination over the entire field, clean lenses, and suitable arrangements in the way of a screen upon which to place the sensitised paper, gives capital results. We have seen some excellent enlargements thus produced.

A Suggestion for the Treatment of Old Nitrate Baths.—At the February meeting of the London Photographic Society, Mr. Johnson stated that, acting upon a hint given by Mr. W. Morgan Brown, he had tried the action of permanganate of potash upon old nitrate baths. He found that the salt became deoxidised, so that after filtration a perfectly colourless solution remained, giving clean pictures entirely free from fog.

New Apparatus.—Mr. Ernest Edwards, of Baker Street, and Mr. Johnson, have each introduced a new portable and very complete pocket apparatus for photographs 2 inches square. The lenses are Ross's.

Effects of Light on Glass.—Photographers have recently given considerable attention to the discolouration of glass by light, a matter of great importance in connection with glass operating rooms; and a paper by Mr. Thomas Gaffield, published in the *American Journal of Science and Art*, was made the subject of discussion at the February meeting of the North London Photographic Society. Mr. Gaffield describes experiments extending over four years, conducted with varieties of glass obtained from France, Belgium, Germany, America, and England. They demonstrate very clearly the degrees of influence which sunlight has on the specimens experimented with. White French plate, and all white sheet glass of the better kind changed to a yellow hue after a month's exposure to strong sunlight, but the dark green, dark blue, and bluish green remained unchanged. Window glass ranging from the white of French plate to the green of English sheet glass, gave the same results, but the dark green, blue, and blue-green remain unchanged. A brownish green sample made in Belgium, also remained unchanged. Every specimen of plate glass tested, except an inferior blue kind, and a

greenish crystal plate of a superior make from Germany, changed. Samples of glass unaltered by three months' exposure nevertheless afterwards discoloured, and only one sample—an American sheet of ordinary blue glass—remained unaltered by twelve months' exposure. In conclusion, Mr. Gaffield states that all this is due to carelessness on the part of glass-makers in their choice of materials not chemically pure. "The sand, the carbonate or sulphate of soda, and the lime, one or all, contain slight impurities of iron, the protoxide of which gives glass a green colour. To correct this, after the batch is partially melted, a little oxide of manganese, called glass-maker's soap, is put into the crucible; some of the oxygen of the manganese flies off to the iron, and converts the protoxide into peroxide of iron. The peroxide gives a yellowish colour to the glass, and this, being complementary to the natural pink of the manganese, is neutralised, and the glass is thereby made of a light colour. When the sunlight acts upon glass thus made, the nice equilibrium between the oxygen of the iron and the manganese is disturbed, and sometimes the yellow, and sometimes the pink or purple colour is produced."

Test for Methyl.—An eminent collodion manufacturer, writing to the *Illustrated Photographer*, says very rightly: "Methyl has no business to be in collodion;" but adds, "yet I do make methylated collodion for photographers, because they will have a cheap article. . . . . It is very easy to destroy the smell of methyl, so that the spirit cannot be detected by that sense; but it is not so easy to make a wood spirit inert towards nitrate of silver." The writer gives in conclusion the following test for methyl in ether, or alcohol supposed to be purely ethylic: "Distil over into a test-tube a little of the suspected spirit, add a drop or two of solution of corrosive sublimate (very weak), then add excess of caustic potash. If the precipitated oxide is not redissolved, wood spirit is not present."

New Dry Process.—Mr. Carey Lea, in a recent number of the *British Journal of Photography*, gives the following new dry process: "A plate is coated with collodio-bromide, and is thrown as soon as set into a bath of acetate of lead, acetic acid, and gallic acid. It is then simply dried without any other treatment, and so gives an excellent dry plate, very sensitive, and giving satisfactory negatives."

The Photographic Society.—The council of the London Photographic Society has published its annual report of assets and liabilities, without previously submitting it to the members at the annual meeting. This is a somewhat unusual step. The balance sheet, too, is somewhat unusual, for it puts forward as satisfactory, statements proving that the society can only be regarded as solvent by those who accept a back stock of old and valueless journals as worth 100*l.*, and unpaid fees and subscriptions as worth 58*l.* 17*s.* 6*d.*. Yet a member of the council, writing as editor of a weekly contemporary, says: "We have no hesitation in asserting that the society is in a healthy and promising condition." The members should take a more active interest in these matters than they appear to have done, for each is, we believe, individually legally responsible for the society's debts.

Photographs of Eminent Men.—There are, doubtless, many of our readers who are desirous of obtaining the photographs of men distinguished for their devotion to science. This circumstance induces photographers to publish

such portraits from time to time, and we have seen various specimens of their handiwork. Of all the "carte" portraits, however, which have come under our notice, those which have been taken by Mr. Philip Crellin strike us as infinitely the best, both in point of photographic excellence and from their wonderfully truthful expression of feature. Among the instances especially worthy of notice we would call attention to the portraits of Professor Huxley, Sir Henry Thompson, Dr. Odling, and Professor W. A. Miller, which are extremely life-like, and—by no means a usual quality in "photos" —perfectly natural in *pose*.

PHYSICS.

A New Galvanic Battery, which promises to be an extremely useful instrument both to the physicist and the therapeutist, has been recently brought under the notice of the *Chemical Society* by Mr. De la Rue and Dr. Hugo Müller. The following account of it is given by a contemporary:— "The negative plate is of chloride of silver, and the positive plate of zinc, the exciting fluid being salt and water. The one exhibited was of very small size, yet gave indications of considerable intensity. The chloride of silver is fused around a thin silver wire as the negative element, the positive plate being composed of a small rod of zinc which need not be amalgamated. The size of the whole arrangement does not exceed three inches in height, and, with a battery of ten cells excited with salt water, a rapid current of mixed oxygen and hydrogen gases was evolved from acidulated water. When in use the salt brine becomes gradually charged with chloride of zinc, which tends to increase the energy of the battery, the whole arrangement continues in working order until metallic zinc begins to be deposited on the negative element, when the exciting liquid must be changed. For convenience of putting the whole series at once into action, the round bars of zinc and chloride of silver are fastened at the top to a wooden frame, which is made to slide upon glass uprights: when immersed, the chloride of silver undergoes a slow reduction to metallic silver, and this permeates the mass, producing an appearance like virgin arborescent silver.

The Law of the Production of the Electric Light.—A paper on this subject has been written by Prof. Edlund, and read before the Royal Society of Stockholm. The voltaic current is capable of conversion into several varieties of force, and among the number into heat. The heat produced by such a current is proportional to the square of the intensity of the current multiplied by the resistance. The entire quantity of heat generated is proportional consequently to the electro-motive force divided by the resistance of the current, and this sequence holds so long as the current performs no other work except the generation of heat alone. In the luminous arc which constitutes the electric light, material particles are detached by the current from one pole and transferred to the other, and by the mechanical disintegration of the poles an electro-motive force is produced which sends a current in an opposite direction to that of the principal current. The electro-motive force in the luminous arc is independent of the intensity of the current, and

the resistance of the arc is proportional to its length, and increases as the intensity diminishes. The work performed by the current in the luminous arc is proportional to the intensity so long as the electro-motive force of the battery remains constant.

The Electrolysis of Acetic Acid forms the subject of a paper read before the French Academy by M. Burgoin. The apparatus he employs is as follows:—A tube closed at the upper extremity with a caoutchouc cap, and at the lower extremity closed with the exception of a very small hole. Through the cap passes a small syphon tube almost capillary, as well as a platinum wire, which terminating inside the tube in a plate of that metal, forms one electrode. This tube is encircled by a larger one of such capacity, that when the disengaged gas in the interior exerts a pressure of four centimetres, the volume of solution in each tube shall be the same. In the annular space formed by these tubes the other electrode is plunged. Experiments were made with a neutral solution of acetate of potash which had been analysed: after submitting it for six hours to the electrolysing action of four elements, a portion of the liquid was drawn off from the neighbourhood of each pole and analysed. The conclusions arrived at are that the decomposition into carbonic acid and carburetted hydrogen is almost *nil*, and that the greatest loss is at the positive pole. The results of M. Burgoin's experiment would seem to be:—1. The current acts on acetate of potassium as on a mineral substance. 2. In a moderately alkaline solution the oxygen reacts on the elements of the anhydrous acid, and gives rise to a normal oxidation, whence results carbonic acid and hydride of ethylen: $C_8H_6O_6+O_2=2C_2O_4+C_4H_6$. 3. A certain quantity of acid is totally consumed under the influence of oxygen furnished either by the salt or by the alkaline water. 4. The two poles suffer unequal losses. Almost the whole of the salt which disappears belongs to the positive pole. 5. The current acts on the free acetic acid in the same manner as sulphuric acid; it concentrates the acid at the positive pole.—Vide *Comptes Rendus*, tom. lxv. No. 24.

A Metallurgical Spectroscope.—The application of the spectroscope to metallurgical processes has not been confined to England. Professor Osborn, in a letter to the *Scientific American*, gives the following account of an instrument devised by him for this purpose, and of his observation with its acid:—"The instrument complete is so arranged that the observer reads the degree on the scale by the actual light which he is analysing. The very light which comprises, in its flame, the vaporised metal, as lime, iron, chromium, titanium, sodium, &c., discloses to the observer in the spectral form, not only its own nature, but often to a great degree, the approximate quantities found in the original ore or even in the coal used, or from the wasting brick of the furnace. Nothing can exceed the beauty of the spectral forms which suddenly appear and disappear in the otherwise darkened tube, as the observer stands at the 'tunnel head' of the furnace, watching, as it were, the spectral secrets of that terrible flame which pours forth from the stack, especially when, after the 'cast' and consequent cessation of the blast, that blast is again turned on. The bright yellow bar of sodium is almost always present during examination of all flames resulting from the use of any and all forms of anthracite in the furnace and forge, or

from decomposing feldspars. But one of the most striking facts in my examinations occurred at our last analysis of a flame from a re-heating furnace on the Lehigh, at the wire works of Stuart and Co. The workmen held partly out a bar of intensely heated iron on the hearth of the furnace, when, at rapid intervals, the dark lines which are seen in the solar spectrum appeared faintly, but certainly flitting over the spectrum of the fierce flame by which the intensely heated iron was enveloped. An instrument, of a circular form, is in course of construction, under my direction, for the easy examination of these flames, and which may be used at any time and at considerable distances; and I am hoping that such shall be its sensitiveness, that the furnace master may sit in his room and know much of the efficiency and value of the operations proceeding at the furnace by its use. I am situated on a hill, and by means of my instrument, placed upon my dinner table, I can get a beautiful spectrum from a re-heating furnace situated not much less than a half-mile from my instrument, and am able to detect the sodium in the coal, or from the decomposed fire brick, and also any lime, potash, &c., which proceeds from the furnace mouth. I have no doubt that some exceedingly important uses may be made of this discovery of the spectroscope in the line of metallurgical operations."—Vide *Chemical News*, February 14.

The Velocity of Light.—Many comparisons have from time to time been given with a view to supply a popular notion of the rapidity with which light travels; one of the latest is the following, which has been published by Professor Chase, of Boston. He says the velocity of light is the same as would be acquired in one year by a falling body under the influence of an accelerating force equivalent to the force of gravitation at the earth's surface, viz. $32\ 1\text{-}6 \times 86{,}400 \times 365\frac{1}{4} \div 5{,}280 = 192{,}254$ miles per second.

Efflorescence and Hydration find a very physical explanation in a paper published by M. Debray, who states that a hydrated salt has for each temperature a tension of dissociation which is measured by the elastic force of the aqueous vapour which it emits at this temperature. Admitting this, the phenomena of efflorescence and hydration are easily explained. A salt effloresces when the tension of its water vapour is greater than that of the aqueous vapour existing in the atmosphere. A dry salt becomes hydrated when the tension of the aqueous vapour contained in the atmosphere is greater than that which the salt emits at the same temperature. Hydrous salts which do not effloresce owe, then, this property to the fact that the tension of the aqueous vapour emitted by them at ordinary temperatures is always inferior to that commonly possessed by the atmospheric aqueous vapour. These same salts effloresce when placed in an atmosphere where the elastic force of the aqueous vapour contained in the air is less than that which they emit.

Sir David Brewster's Writings.—Some idea of the industry of the great philosopher who has just gone from among us may be gathered from the following lists, in which a record of some of his labours is briefly given. His essays have been contributed to the Transactions of the Royal Societies of London and Edinburgh, and those of the Royal Irish Academy, to the *Edinburgh Encyclopædia*, the *Edinburgh Philosophical Journal*, the *Edinburgh Journal of Science*, the *Philosophical Magazine* (of which Sir David was one

of the editors), the *Edinburgh* and *North British Reviews*, the Transactions of the British Association, the Library of Useful Knowledge, have all been enriched by numerous products of his pen, bearing upon almost every department of physical science. His separate works were:— *A Treatise on New Philosophical Instruments for Various Purposes in the Arts and Sciences, with Experiments on Light and Colours*, 1813; *A Treatise on the Kaleidoscope*, 1819; *Notes to Robinson's System of Mechanical Philosophy*, 1822; *Letters and Life of Euler*, 1823; *Letters on Natural Magic*, dedicated to Sir Walter Scott, 1824; *A Treatise on Optics*, 1831; *Life of Sir Isaac Newton*, 1831; *The Martyrs of Science; or, Lives of Galileo, Tycho Brahe, and Kepler*, 1841; *More Worlds than One, the Creed of the Philosopher and the Hope of the Christian*—an answer to Professor Whewell's *Plurality of Worlds*, 1854; *Memoirs of the Life, Writings, and Discoveries of Sir Isaac Newton*, 1855. He also edited a translation of Legendre's *Geometry*.

Professor Wheatstone has received the honour of Knighthood, a recognition of merit, assuredly late, and well deserved.

Heat Generated by Magnetism.—We find the following recorded in a contemporary as an experiment devised by M. Louis D'Henry. If a magnet with poles pointing upwards be rotated rapidly on a vertical axis below a small copper plate, on which a glass flask is placed, the air contained in the flask will be heated, and its expansion may be made visible by any suitable arrangement, or a copper vessel of water might be substituted for the flask and plate, and by a sufficiently rapid rotation the water might, no doubt, be made to boil.

The Theory of Phlogistics has received very elaborate discussion from Mr. Rodwell in an excellent paper published in the *Philosophical Magazine* for January.

The Sprengel Air-Pump is of cour e familiar to our professional readers. The following account of it, however (from the science columns of the *Illustrated London News*) is so simple and intelligible that we extract it for the benefit of amateurs. It consists substantially of a glass tube with a funnel at the top containing quicksilver. If the quicksilver be permitted to flow down the tube in drops, each drop will act as a piston and carry some of the contained air before it, and a vacuum will thus be produced in the tube or in any vessel with which it may be connected sidewise by a pipe. The mercurial column will, in fact, produce a vacuum like that called a Torricellian vacuum, and which is obtained by filling a tube, over 30 inches long and closed at one end, with mercury, in the manner of a barometer; and then, by inverting the tube, the mercury will in part run out and a vacuum will be formed above the mercury. A column of mercury about 30 inches high produces a pressure which balances the pressure of the atmosphere.

Floating Soap-bubbles in Carbonic Acid.—Mr. Woodward of the Midland Institute, Birmingham, describes the following method of preparing a glass-case in which to hold the carbonic acid, and of preparing the bubbles for the purpose of experimentations. A vessel in which to hold the carbonic acid may conveniently and cheaply be made by getting five square pieces of glass—they should be at least 30 or 40 c. square—and joining their edges by bibulous paper soaked in glue, so as to form a cubic shaped vessel. When the gl. · is dry a strip of cloth about two centimetres wide should be glued

in the inside of the vessel, and lap over the edges, not only for protecting the ragged edges of the glass, but to prevent the bubbles from bursting. The carbonic acid used should be passed through a wash-bottle containing potassic carbonate, so as to free it from the vapour of hydrochloric acid, and then conducted into the cubic vessel until it is quite full. If a bubble now be blown with the glycerine and soap solution it may be floated easily on the carbonic acid. Should a draught carry it to the side of the vessel the strip of cloth will cause it to rebound again to the centre, and thus the bubble may float for many seconds, or even for a minute or two.—Vide *Chemical News*, No. 419.

Diffusion of Liquids and Gases.—In one of last year's numbers of the *Journal für Praktische Chemie*, Herr Merz describes a most instructive and pleasing experiment, by which the principle of diffusion may be illustrated. A portion of the shell of an egg having been removed by the action of hydrochloric acid, leaving the membrane exposed, the egg is to be suspended in water from the arm of a balance, a counterpoise being placed in the opposite scale. In about half an hour the weight of the egg has sensibly increased, as the position of the balance-beam will show, in consequence of the passage of water through the membrane. If, now, alcohol be substituted for the water, and the weights readjusted so as to bring the beam horizontal, it will soon commence to move in the opposite direction, showing that the egg has become lighter by the diffusion of water into the alcohol. The diffusion of vapour may be exhibited by tying a diaphragm of india-rubber—a portion of a small toy balloon will answer the purpose—over the mouth of a funnel, the other end being in communication, by means of an elastic tube, with a vessel of water. The funnel being inverted over a dish containing ether, which, however, the diaphragm is not to touch, the vapour of this fluid will pass rapidly into the funnel, the air being observed to escape in bubbles in the water at the small end. Remove now the vessel of ether, and the operation will be reversed, the vapour passing through the diaphragm into the atmosphere. In order to fill the vacuum thus created the water will rise in the tube, the lower part of which should be of glass to render this apparent, and the diaphragm will be curved inwards. These experiments are particularly instructive, and are within reach of every one. The balance may be extemporised by means of a light bar of wood.

Scientific Memoirs.—All workers have felt the disadvantages of the absence of anything like a satisfactory physical bibliography, such as the zoologists possess in Carus' excellent book. They will be glad, therefore, to learn that the first volume of the *Catalogue of Scientific Papers*, which has been in preparation for a long time by a committee of the Royal Society, has been published. It is a 4to volume of about 1000 pages, and includes the titles of papers and authors' names from A to Clu. The second volume also approaches completion.

Registration of Earth-Currents of Electricity.—The earth-currents which are frequently such a source of annoyance to the workers in telegraphic offices have been recently investigated by Professor Airey, who has devised a combination of the galvanometer and photography, by means of which their currents are registered. Professor Airey's paper was read at a very recent meeting of the Royal Society.

A Battery which works for Years has been invented by Herr Böettger. It retains its activity for several years, and is admirably adapted to the working of electric clocks, ringing electric bells, and the requirements of electro-metallurgy. Each cell consists of a cylinder of thick plate zinc enclosed in a glass jar. In the centre of the cylinder is placed a bar of compact coke, and the intervening space is packed with a powder composed of a mixture of equal volumes of pounded sulphate of magnesia and common salt, moistened with a saturated solution of these two substances. The salt mixture is moistened from time to time, and the zinc of one cell carefully combined with the coke of the next, according to the usual method.—Vide *The Artizan*, January.

The Temperature of Gaseous Flames.—In a late number of Poggendorff's *Annalen*, Herr Bunsen publishes a paper on the temperature of the flames of carbonic oxide and hydrogen, which is worthy of the notice of physicists. Among other interesting points, the author states that a mixture of carbonic oxide and oxygen, in the proportions proper for combustion, will be heated from 0° to 3033 centigrade; of hydrogen and oxygen, from 0° to 2814° centigrade; a mixture of carbonic oxide and air, from 0° to 1997° centigrade; and a mixture of hydrogen and air from 0° to 2024° centigrade.

The Lamellar Polarization of Alum.—In a paper read before the Academy of Sciences of Berlin, Herr Reusch discussed this very interesting phenomenon. He thinks that the polarisation is as supposed by Biot—partly due to the fact, that the crystal is made up of a multitude of small octahedra, and that these not being in immediate contact, they act in the same manner as a polarising bundle of glass plates. But he says this by no means explains the whole of the phenomena, and hence he feels compelled to admit that the crystal has in a slight degree the power of double refraction.—Vide *L'Institut*, March 18.

The Interference of Sonorous Waves rendered Visible.—Herr Stefan has described an ingenious apparatus for this purpose. The account is published in a paper presented to the Academy of Vienna, and is given in abstract in *L'Institut* of February 19.

ZOOLOGY AND COMPARATIVE ANATOMY.

A New Species of Monkey.—At the meeting of the *Zoological Society*, on the 27th of February, Dr. J. E. Gray, F.R.S., read a description of a new species of monkey of the genus *Colobus*, from Zanzibar. The species had been discovered by Dr. J. Kirk, and had been forwarded by him to the British Museum. Dr. Gray therefore proposed to call it *C. Kirki.*

The Development of a Dragon-Fly.—The development of a species of dragon-fly (genus *Diplax*) has been very carefully worked out, and has been duly described and admirably figured by Dr. A. S. Packard, Jun., in a paper read before the American Association for the Advancement of Science. The paper has been published in the *American Naturalist* for February, and it is well worth attention.

Parallelism of Fore and Hind Legs of Vertebrates.—In the Journal just

referred to our readers will find also an interesting paper on the homologies of the fore and hind extremities. In this the author takes up the theory of Maclise and also that lately advanced by Mr. St. Geo Mivart, and confidently rejects both as ingenious but unsatisfactory speculations.

American Zoologists.—Students of Zoology in this country often require to know whether a particular branch of Natural History has received attention in America, and if so, by whom? This question, so difficult for the beginner, is being solved in a list called the *American Naturalist's Directory*, which is being published in the *Proceedings of the Essex* (U.S.) *Institute.* It is arranged under the heading of subjects, and has already made considerable progress.—Vide *Proceed. Essex Instit.*, vol. v. No. v.

The Anatomy of Helix and Limax.—A paper was recently read before the Microscopical Society which shows the necessity for submitting papers to a careful scrutiny before permitting them to be read at the meetings. The paper purported to be an original communication detailing the anatomical differences between certain species of Limax and Helix; but it really contained hardly anything which has not been pointed out long ago by other observers than its author, Mr. Ed. T. Newton. Indeed, unless we are much mistaken, every anatomical feature described by Mr. Newton may be found in Moquin-Tandon's very unreliable pair of volumes, entitled *Histoire Naturelle des Mollusques terrestres et fluviatiles.*

New Species of Epistylis.—Mr. Tatem, in a paper on new microscopic animals, quotes the following account of two new species of *Epistylis* recently discovered by him. *Epistylis ovalis.*—Zooids two, small $\frac{1}{450}$, colourless, oval, with a contracted raised margin or lip; main stem and branchlets long, slender, and of equal thickness. Very rare. On Anacharis. *Epistylis umbellatus*, n. sp.—It is seldom indeed that so perfect an example of this elegant form of *Epistylis* as that figured is met with: commonly the stalk, with some eight or sixteen zooids, more commonly the bare stalk, is alone obtainable. So far as I am yet aware, it is found in one ditch only, near the wire mills on the Kennet river, near this town (Reading). The zooids, which easily become detached, are minute, oval, colourless; main stem very long, slender, dividing into four branchlets, which again subdivide into four each, in an umbellate manner, smooth, and of a light colour.—*Microscopical Transactions,* January.

Origin of Vibrio and Bacterium.—Some very curious experiments, which seem to show that yeast is the source of Bacteria, have been made by a German lady, Frau Lüders, and are reported in Schultze's *Archiv für Microscopische Anatomie*, Bd. 3, Ht. 3. The experiments consisted in sowing in test-glasses, specially prepared, and filled with boiled flesh-water, at the moment they were taken from the boiling apparatus, the spores of various *fungi*, taken by means of forceps which had previously been heated to redness; the tubes were then closed with varnish, &c. When the tubes thus prepared were placed, immediately after the sowing, into the warm bath, a cloudiness was often observed in the fluid in the course of a few hours, and within twenty-four hours, they always swarmed with *Vibriones*, whilst at the same time the contents of a similar tube, containing the same fluid, and prepared in precisely the same way, but into which no spores had been introduced, remained unchanged. The *Vibriones* produced

in this way by direct germination from the spores of *fungi* differ in no respect from those which are commonly found in putrescent fluids. Madame Lüders is induced to believe that the blood of living animals contains *Vibriones*, either in the catenated form or in that of the constituent granules; but during life, and until putrescency commences, these are always quiescent, and show no signs of active existence.—Vide *Microscopical Journal* for January.

Asiatic and American Newts.—Mr. St. Geo Mivart has published his paper on the affinities of Dr. Gray's new Siamese species *Plethodon persimilis*, in which are stated his reasons for differing from Dr. Gray in placing this newt in a new genus. Mr. Mivart says that, though struck with the resemblance of *Plethodon persimilis* to *P. glutinosus*, it occurred to him as remarkable that two species so widely separated as those of Siam and North America should have any close affinity. This led him to make a careful examination, from which he learned that there are the following points of difference between *P. persimilis* and *P. glutinosus*. The distinction may be thus tabulated:—

P. glutinosus.	*P. persimilis.*
1. Limbs feeble.	1. Well developed.
2. Length of fore limb much less than half distance between fore and hind limbs.	2. Length of fore-limb exactly half this distance.
3. Length of hind-limb one half distance between hind and fore limbs.	3. More than this.
4. Third and fourth toes shorter than cleft of mouth.	4. Longer than cleft of mouth.
5. Trunk with thirteen lateral cross-folds.	5. Only twelve.
6. Tail sub-cylindrical at base.	6. Compressed.
7. Tongue large, covering whole bottom of mouth, hind margin free.	7. Narrow, elliptical, not covering whole bottom of mouth, without free posterior margin.
8. Series of palatine teeth, *distinctly* interrupted in middle.	8. Series sub-continuous.

These points of difference justify Mr. Mivart in placing the Siamese newt in a new genus, whose name, founded on lingual characters, is *Pectoglossa*. He retains Dr. Gray's specific title.

The Muscular Anatomy of the Iguana forms the subject of another memoir which Mr. Mivart has sent us, and which is amply illustrated, and deserves the attention of herpetologists.

Termination of Nerves in Muscles of Animals.—Notwithstanding all that Dr. Beale has written and demonstrated on this point, we still find continental histologists adhering to the old opinion that there is a terminal plate to which the ultimate fibres are conjoined. The latest paper on this subject is that of Professor Trinchese of Genoa, whose conclusions have been thus formulated.* 1. In all animals in which it has been possible to study the termination of motor nerves, a special organ has been found, named the

* *Quart. Jour. Micros. Sci.*, January.

"motor plate" (*plaque motrice*), at the extremity of the cylinder axis. 2. The union of the nervous element with the muscular bundle is accomplished in the following manner. When the muscular bundle is provided with sarcolemma, and the nervous element with a sheath, this latter becomes fused with the envelope of the primitive muscular bundle, at the point where the nervous element meets the muscular bundle. At this same point, or a little before, the medullary substance stops, whilst the *cylinder axis* pursues its course, and penetrates the "motor plate." 3. The motor plate is placed beneath the sarcolemma. It presents usually the form of a cone, with its summit directed to the side of the nerve-tube, whilst the base is applied to the primitive muscular fibres. 4. This plate is formed by two superposed and very distinct layers, especially in those animals provided with large "plates," as, for instance, n the torpedo. The substance of the superior layer is granular, that of the inferior layer is perfectly homogeneous, and probably it is nothing more than a thickening of the *cylinder axis*. 5. In the substance of the granular layer of the plate is found, in the torpedo, a system of canals, in which the cylinder axis ramifies, forming a coarse network. These canals are limited by a sheath, which forms their walls. 6. When the muscular bundles possess a central canal, the granular substance of the plate is continuous with the granular substance contained in this canal. 7. In animals provided only with smooth muscular fibres the *cylinder axis* traverses the granular substance of the plate, dividing itself into two filaments, which pass to the two extremities to terminate in the points of the contractile element. 8. Everything tends to the belief that each primitive muscular fibre has but one motor plate. In this, one or several nervous elements can terminate, arising from the subdivision of one and the same nerve-tube. 9. The diameter of the motor plate augments in proportion to the thickness of the primitive muscular bundle.

Fishes of the Iberian Peninsula is the name of a paper read before the Austrian Academy by Herr Steindacher. This fauna includes 69 species, belonging to the following 9 families:—Berycidæ, Percidæ, Scienidæ, Pristipomidæ, Sparidæ, Mullidæ, Triglidæ, Trachinidæ, and Trichiurida. Seven of the 69 species have been for the first time added to European Ichthyology. The author stated that his observations convince him that many of the so-called specific characters of fishes, especially of the Mediterranean basin, are based upon sexual differences, and are therefore dangerous and unreliable.—See *Report of the Meetings of the Vienna Academy* for October.

Parasitic Crustacea.—In one of the numbers of the *American Journal*, Mr. Verrill describes a curious instance of crustacean parasitism. He says, in examining some specimens of sea-urchins from the coast of Peru, he observed that in many instances the anal contour was imperfect, or very much deformed. An examination of the interior in these cases detected the presence of a minute crustacea (*Fabia Chilensis*) analogous to that found in the oyster. It was attached to the lower portion of the intestines, and was enclosed in a species of cyst. The crustacea found were, in nearly every instance, females laden with ova, and it seems as though, when once they enter, they are compelled to remain prisoners for life. In all probability the parasite enters when very small, by the anal aperture, and by its constant growth and consequent pressure on the shell disturbs this latter.

Classification of Rodents.—Herr Fitzinger has presented the second part of his memoir on this subject to the Vienna Academy. The natural families he establishes are (1) Mures, (2) Hypudæi, (3) Castores, (4) Dispodes, (5) Eryomes, (6) Psammoryctæ, (7) Hystrices, (8) Caviæ, (9) Lepores.—Vide *L'Institut*, December 26, 1867.

Circulatory Apparatus of Starfish.—M. Jourdain has been publishing the results of his researches on this part of the anatomy of *Asteracanthion rubens.* He corroborates Milne Edwards' statement that the general cavity of the body is closed. This cavity contains a liquid holding in suspension numerous yellow globules, of about the $\frac{1}{60}$th of a millimetre. These globules are set in motion by the vibratile cilia which clothe the surface of the general cavity and direct the currents, exactly as was pointed out years ago by Dr. Sharpey, of University College. In the integument may be seen a number of cæca, distributed in groups about 2 millimetres long, and which are diverticula of the cavity. These, from his experiments on them, M. Jourdain styles *respiratory cæca.* He states that he has failed to find the complex vascular system described by Tiedemann and Volkmann, and he expresses considerable doubt as to its existence. The so-called heart of the star-fish he has described to be nothing more than a glandular mass, whose supposed blood-vessels are only muscles and tendons. He denies also the existence of more than one *buccal vascular ring*, which he says is connected with a series of tubes quite distinct from the general cavity.—Vide *Procès Verbaux* of the Société Philomathique of Paris for 1867, and *L'Institut*, December 26.

Professor Huxley's Lectures on Invertebrates, which have been delivered before the College of Surgeons, should be read by all zoologists. Clear abstracts of them have appeared in the *Medical Times and Gazette* for February and March.

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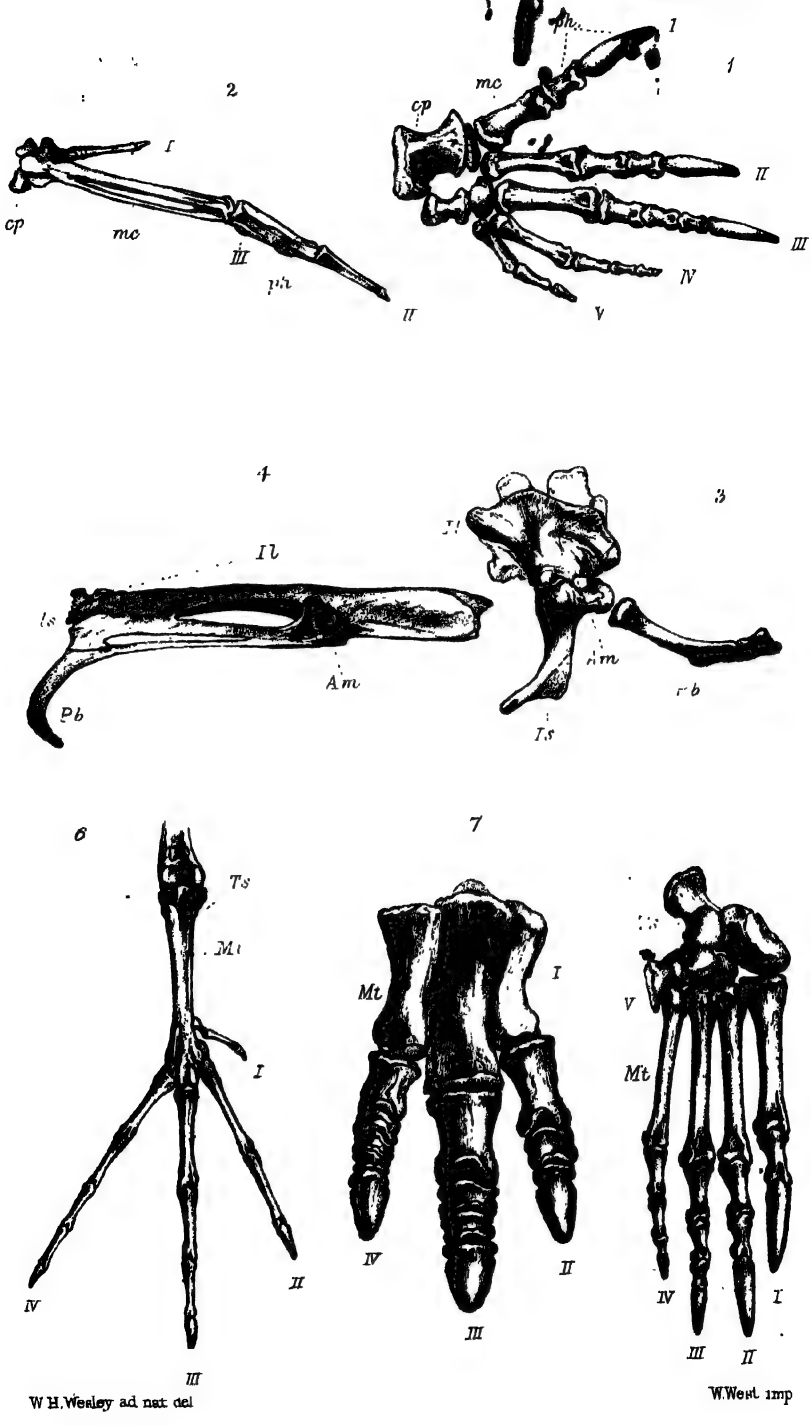
Plate XVII



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ON THE ANIMALS WHICH ARE MOST NEARLY INTERMEDIATE BETWEEN BIRDS AND REPTILES.*

By Professor Huxley, LL.D., F.R.S.

THOSE who hold the doctrine of Evolution (and I am one of them) conceive that there are grounds for believing that the world, with all that is in it and on it, did not come into existence in the condition in which we now see it, nor in anything approaching that condition. On the contrary, they hold that the present conformation and composition of the earth's crust, the distribution of land and water, and the infinitely diversified forms of animals and plants which constitute the present population of the globe, are merely the final terms in an immense series of changes which have been brought about, in the course of immeasurable time, by the operation of causes more or less similar to those which are at work at the present day.

Perhaps this doctrine of Evolution is not maintained consciously and in its logical integrity by a very great number of persons.† But many hold particular applications of it without committing themselves to the whole; and many, on the other hand, favour the general doctrine without giving an absolute assent to its particular applications. Thus, one who adopts the nebular hypothesis in Astronomy, or is a Uniformitarian in Geology, or a Darwinian in Biology, is, so far, an adherent of the doctrine of Evolution. And, as I can testify from personal experience, it is possible to have a complete faith in the general doctrine of Evolution and yet to hesitate in accepting the Nebular, or the Uniformitarian, or the Darwinian hypotheses in all their integrity and fulness. For many of the objections

* A Lecture delivered before the Royal Institution of Great Britain on February 7, 1868.

† The only complete and systematic statement of the doctrine with which I am acquainted is that contained in Mr. Herbert Spencer's "System of Philosophy;" a work which should be carefully studied by all who desire to know whither scientific thought is tending. The volumes at present published are entitled, "First Principles," and "Principles of Biology."

which are brought against these various hypotheses affect them only, and even if they be valid, leave the general doctrine of Evolution untouched.

On the other hand, it must be admitted that some arguments which are adduced against particular forms of the doctrine of Evolution, would very seriously affect the whole doctrine if they were proof against refutation. For example, there is an objection which I see constantly and confidently urged against Mr. Darwin's views, but which really strikes at the heart of the whole doctrine of Evolution, so far as it is applied to the organic world. It is admitted on all sides that existing animals and plants are marked out by natural intervals into sundry very distinct groups:—Insects are widely different from Fish—Fish from Reptiles—Reptiles from Mammals—and so on. And out of this fact arises the very pertinent objection, How is it, if all animals have proceeded by gradual modification from a common stock, that these great gaps exist? We, who believe in Evolution, reply, that these gaps were once non-existent; that the connecting forms existed in previous epochs of the world's history, but that they have died out.

Naturally enough then, we are asked to produce these extinct forms of life. Among the innumerable fossils of all ages which exist, we are asked to point to those which constitute such connecting forms. Our reply to this request is, in most cases, an admission that such forms are not forthcoming, and we account for this failure of the needful evidence by the known imperfection of the geological record. We say that the series of formations with which we are acquainted is but a small fraction of those which have existed, and that between those which we know there are great breaks and gaps. I believe that these excuses have very great force; but I cannot smother the uncomfortable feeling that they are excuses. If a landed proprietor is asked to produce the title-deeds of his estate, and is obliged to reply that some of them were destroyed in a fire a century ago, that some were carried off by a dishonest attorney, and that the rest are in a safe somewhere, but that he really cannot lay his hands upon them; he cannot, I think, feel pleasantly secure, though all his allegations may be correct, and his ownership indisputable. But a doctrine is a scientific estate, too often the Philosopher's only estate, and the holder must always be able to produce his title-deeds, in the way of direct evidence, or take the penalty of that peculiar discomfort to which I have referred. You will not be surprised, therefore, if I take this opportunity of pointing out that the objection to the doctrine of Evolution, drawn from the supposed absence of intermediate forms in the fossil state, certainly does not hold good in all cases. In short, if I cannot produce the complete title-deeds of the doctrine of

animal Evolution, I am able to show a considerable piece of parchment evidently belonging to them.

To superficial observation no two groups of beings can appear to be more entirely dissimilar than Reptiles and Birds. Placed side by side, a Humming-bird and a Tortoise, an Ostrich and a Crocodile, offer the strongest contrast, and a Stork seems to have little but animality in common with the Snake it swallows. Careful investigation has shown, indeed, that these obvious differences are of a much more superficial character than might have been suspected, and that Reptiles and Birds do really agree much more closely than Birds with Mammals, or Reptiles with Amphibians. But still, "though not as wide as a church-door or as deep as a well," the gap between the two groups, in the present world, is considerable enough.

Without attempting to plunge into the depths of anatomy, and confining myself to that osseous system to which those who desire to compare extinct with living animals are almost entirely restricted, I may mention the following as the most important differences between all the Birds and Reptiles which at present exist.

1. The pinion of a Bird, which answers to the hand of a man or to the forepaw of a Reptile, contains neither more nor fewer than three fingers. These answer to the thumb and the two succeeding fingers in man, and have their metacarpals connected together by firm bony union, or, in other words, are ankylosed. Claws are developed upon the ends of at most two of the three fingers (that answering to the thumb and the next), and are sometimes entirely absent (Plate XXVII. fig. 2). No Reptile with well-developed forelimbs has so few as three fingers; nor are the metacarpal bones of these ever united together; nor do they (Plate XXVII. fig. 1) present fewer than three claws at their terminations (with the exception of the marine *chelonia*).

2. The breast-bone of a Bird becomes converted into a membrane-bone, and ossification commences in it from at least two centres. The breast-bone of no Reptile becomes converted into membrane-bone, nor does it ever ossify from several distinct centres.

3. A considerable number of caudal and lumbar, or dorsal, vertebræ unite together with the proper sacral vertebræ of a Bird to form its "sacrum." In Reptiles the same region of the spine is constituted by the one or two sacral vertebræ.

4. In Birds the haunch-bone (ilium) extends far in front of, as well as behind, the acetabulum; the ischia and pubes are directed backwards, almost parallel with it and with one another; and the ischia do not unite in the ventral middle line of the body (Plate XXVII. fig. 4). In Reptiles, on the contrary, the

haunch-bone is not greatly produced in front of the acetabulum; and the axes of the ischia and pubes diverge and lie more or less at right angles to that of the ilium. The ischia always unite in the middle ventral line of the body (Plate XXVII. fig. 3).

5. In all Birds the axis of the thigh-bone lies nearly parallel with the median plane of the body (as in ordinary *Mammalia*) in the natural position of the leg. In Reptiles it stands out at a more or less open angle with the median plane.

6. In Birds one half of the tarsus is inseparably united with the tibia, the other half with the metatarsal bone of the foot. (Plate XXVII. fig. 6). This is not the case in Reptiles (Plate XXVII. fig. 5).

7. Birds never have more than four toes, the fifth being always absent. The metatarsal of the hallux, or great toe, is always short and incomplete above.* The other metatarsals are ankylosed together, and unite with one half of the tarsus, so as to form a single bone, which is called the *tarsometatarsus* (Plate XXVII. fig. 6). Reptiles with completely developed hind-limbs have at fewest four toes, the metatarsals of which are all complete and distinct from one another (Plate XXVII. fig. 5).

Although all existing Birds differ thus definitely from existing Reptiles, one comparatively small section comes nearer Reptiles than the others. These are the *Ratitæ*, or Struthious birds, comprising the Ostrich, Rhea, Emeu, Cassowary, *Apteryx*, and the but recently extinct (if they be really extinct) birds of New Zealand, the *Dinornithidæ*, which attained gigantic dimensions. All these birds are remarkable for the small size of their wings, the absence of a crest or keel upon the breastbone, and of a complete furcula; in many cases, for the late union of the bones of the pinion, the foot, and the skull. In this last character, in the form of the sternum, of the shoulder-girdle, and in some peculiarities of the skull, these birds are more reptilian than the rest; but the total amount of approximation to the reptilian type is but small, and the gap between Reptiles and Birds is but very slightly narrowed by their existence.

How far can this gap be filled up by a reference to the records of the life of past ages? This question resolves itself into two:—

1. Are any fossil Birds more reptilian than any of those now living?

2. Are any fossil Reptiles more bird-like than living reptiles? And I shall endeavour to show that both these questions must be answered in the affirmative.

* It is almost always free—the Frigate bird presenting the only example of its ankylosis with the rest with which I am acquainted.

It is very instructive to note by how mere a chance it is we happen to know that a fossil bird, more reptilian in some respects than any now living, once existed. Bones of birds have been obtained from rocks of very various dates in the Tertiary series without revealing any forms but such as would range themselves among existing families. A few years ago the great Mesozoic formations had yielded only the few fragmentary ornitholites which have been discovered in the Cambridge greensand, and which are insufficient for the complete determination of the affinities of the bird to which they belonged. However, the very fine calcareous mud of the ancient oolitic seabottom which has now hardened into the famous lithographic slate of Solenhofen, and has preserved innumerable delicate organisms of the existence of which we should otherwise have been, in all probability, totally ignorant, in 1861 revealed the impression of a feather to the famous palæontologist, Herman von Meyer. Von Meyer named the unknown bird to which this feather belonged *Archæopteryx lithographica*, and in the same year, the independent discovery by Dr. Häberlein of the precious skeleton of the *Archæopteryx* itself, which now adorns the British Museum,* demonstrated the chief characters of the very early bird thus named. But it must be remembered that this feather and this imperfect skeleton are the sole remains of birds which have yet been obtained in all that great series of formations known as Wealden and Oolite, which partly lie above and partly correspond with, the Solenhofen slates. Some palæontologists may be forced by a sense of consistency to declare that the class of birds was created in the sole person of *Archæopteryx* during the deposition of the Solenhofen slates; that they disappeared during the Wealden, to be re-created in the Greensand; and that they vanished once more during the Cretaceous epoch and were regenerated in the Tertiaries; but I incline to the hypothesis that many birds beside *Archæopteryx* existed throughout all this period of time, and that we know nothing about them, simply because we do not happen to have hit upon those deposits in which their remains are preserved.

Now, what is this *Archæopteryx* like? Unfortunately, the skull is lost, but the leg and foot, the pelvis, the shoulder-girdle, and the feathers, so far as their structure can be made out, are completely those of existing ordinary birds. On the other hand, the tail is very long, and more like that of a reptile than that of a bird in this respect. Two digits of the manus have curved claws, much stronger than those of any existing bird; and, to all appearance, the metacarpal bones are quite free and

* The fossil has been described by Professor Owen in the "Philosophical Transactions" for 1863.

disunited. Thus it is a matter of fact that, in certain particulars, the oldest known bird does exhibit a closer approximation to reptilian structure than any modern bird.

Are any fossil reptiles more bird-like than those which now exist? As in the case of birds, the Tertiary formations yield no trace of reptiles which depart from the type of the existing groups. But, otherwise than is true of birds, the newest of the Mesozoic formations, the Chalk, makes us acquainted with reptiles, which, at first sight, seem to approach birds in a very marked manner. These are those flying reptiles, the Pterodactyles, which resemble the great majority of birds in the presence of air-cavities in their bones, in the wonderfully bird-like aspect of their coracoid and scapula, and in their broad sternum with its median crest. Furthermore, in some of the Pterodactyles, the premaxillæ and the symphysial part of the mandibles were prolonged into beaks, which appear to have been sheathed in horn, while the rest of each jaw was armed with teeth. But horn-sheathed beaks are found in living chelonian reptiles as well as in birds; the structure of the scapulocoracoid arch and of the sternum, and the pneumaticity of the bones, vary greatly among birds themselves; and these characters of the Pterodactyles may be merely adaptive modifications. On the other hand, the manus has four free digits, the three inner of which are strongly clawed, while the fourth is enormously prolonged, in total contrast to the abortion of the corresponding digit in birds. The pelvis is as wholly unlike that of birds as are the hind-limb and foot.

Thus it appears that Pterodactyles, among Reptiles, approach birds much as Bats, among Mammals, may be said to do so. They are a sort of reptilian Bats * rather than links between Reptiles and Birds, and it is precisely in those organs, the manus and the pes, which, in birds, are the most characteristically ornithic, that they depart most widely from the ornithic type. Clearly, then, the passage from Reptiles to Birds is not from the flying Reptile to the flying Bird. Let us try another line. I have already observed that, in the existing world, the nearest approximation to Reptiles is presented by certain land Birds, the Ostriches and their allies, all of which are devoid of the power of flight by reason of the small relative size of their fore limbs and of the character of their feathers. Can we find any extinct Reptiles which approached these flightless birds, not merely in the weakness of their fore limbs, but in other and more important characters? I imagine that we can, if we cast our eyes in what, at first sight, seems to be a most unlikely direction.

* It will be understood that I do not suggest any direct affinity between Pterodactyles and Bats.

The *Dinosauria*, a group of extinct reptiles, containing the genera *Iguanodon, Hadrosaurus, Megalosaurus, Poikilopleuron, Scelidosaurus, Plateosaurus*, &c., which occur throughout the whole series of the Mesozoic rocks, and are, for the most part, of gigantic size, appear to me to furnish the required conditions. In none of these animals is the skull,* or the cervical region of the vertebral column, completely known, while the sternum and the manus have not yet been obtained in any of the genera. In none has any trace of a clavicle been observed. With regard to the characters which have been positively determined, it has been ascertained, that: 1. From four to six vertebræ enter into the composition of the sacrum, and become connected with the ilia in a manner which is partly ornithic, partly reptilian. 2. The ilia are prolonged forwards in front of the acetabulum as well as behind it, and the resemblance to the bird's ilium thus produced is greatly increased by the widely arched form of the acetabular margin of the bone, and the extensive perforation of the floor of the acetabulum (Plate XXVIII. fig. 3, *Il.*). 3. The other two components of the *os innominatum* have not been observed actually in place; indeed, only one of them is known at all, but that one is exceedingly remarkable from its strongly ornithic character (Plate XXVIII. fig. 3, *Is.*). It is the bone which has been called "clavicle" in *Megalosaurus* and *Iguanodon* by Cuvier and his successors, though the sagacious Buckland had hinted its real nature.† But these bones are not in the least like the clavicles of any animal which possesses a clavicle, while they are extremely similar to the ischia of such a bird as an ostrich (Plate XXVIII. fig. 1. *Is.*); and in the only instance in which they have been found in tolerably undisturbed relation with other parts of the skeleton, namely, in the Maidstone *Iguanodon*, they lie, one upon each side of the body, close to the ilia. I hold it to be certain that these bones belong to the pelvis, and not to the shoulder-girdle, and I think it most probable that they are ischia; but I do not deny that they may be pubes. 4. The head of the femur is set-on at right angles to the shaft of the bone, so that the axis of the thigh-bone must have been parallel with the middle vertical plane of the body, as in birds. 5. The posterior surface of the external condyle of the femur presents a strong crest, which passes between the heads of the fibula and the tibia as in birds. There is only a rudiment of this structure in other reptiles. 6.

* The cranium of *Scelidosaurus* is most completely preserved, but lacks the extremity of the snout.

† The so-called "coracoid" of *Megalosaurus* is the ilium. I am indebted to Professor Phillips, and to the splendid collection of Megalosaurian remains which he has formed at Oxford, for most important evidence touching this reptile.

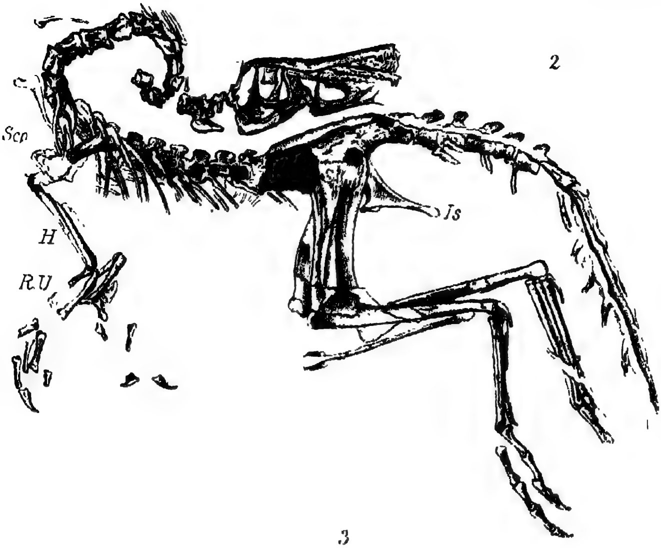
The tibia has a great anterior or "procnemial" crest, convex on the inner, and concave on the outer, side. Nothing comparable to this exists in other reptiles, but a correspondingly developed crest exists in the great majority of birds, especially such as have great walking or swimming powers. 7. The lower extremity of the fibula is much smaller than the other; it is, proportionally, a more slender bone than in other reptiles. In birds the distal end of the fibula thins away to a point, and it is a still more slender bone. 8. *Scelidosaurus* has four complete toes, but there is a rudiment of a fifth metatarsal. The third or middle toe is the largest, and the metatarsal of the hallux is much smaller at its proximal than at its distal end. *Iguanodon* has three large toes, of which the middle is the longest. The slender proximal end of a first metatarsal has been found adherent to the inner face of the second, so that if the hallux was completely developed it was probably very small. No rudiment of the outer toe has been observed (Plate XXVIII. fig. 7). It is clear, from the manner in which the three principal metatarsals articulate together, that they were very intimately and firmly united, and that a sufficient base for the support of the body was afforded by the spreading out of the phalangeal regions of the toes.

From the great difference in size between the fore and hind limbs, Mantell, and more recently Leidy, have concluded that the *Dinosauria* (at least, *Iguanodon* and *Hadrosaurus*) may have supported themselves, for a longer or shorter period, upon their hind legs. But the discovery made in the Weald, by Mr. Beckles, of pairs of large three-toed footprints, of such a size and at such a distance apart that it is difficult to believe they can have been made by anything but an *Iguanodon*, lead to the supposition that this vast reptile, and perhaps others of its family, must have walked, temporarily or permanently, upon its hind legs. However this may be, there can be no doubt that the hind quarters of the *Dinosauria* wonderfully approached those of birds in their general structure, and therefore that these extinct Reptiles were more closely allied to birds than any which now live.

But a single specimen, obtained from those Solenhofen slates, to the accident of whose existence and usefulness in the arts palæontology is so much indebted, affords a still nearer approximation to the "missing link" between reptiles and birds. This is the singular reptile which has been described and named *Compsognathus longipes* by the late Andreas Wagner, and some of the more recondite ornithic affinities of which have been since pointed out by Gegenbaur (Plate XXVIII. fig. 2). Notwithstanding its small size (it was not much more than two feet in length), this reptile must, I think, be placed among, or

Plate XVIII

2



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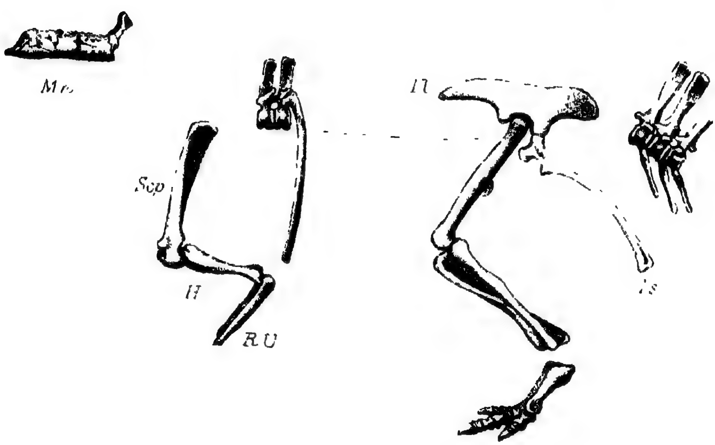

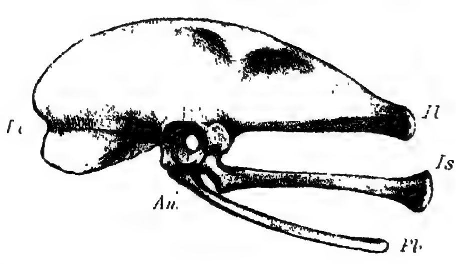

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close to, the *Dinosauria*; but it is still more bird-like than any of the animals which are ordinarily included in that group. *Compsognathus longipes* has a light head, with toothed jaws, supported upon a very long and slender neck. The ilia are prolonged in front of and behind the acetabulum. The pubes seem to have been remarkably long and slender, and this circumstance rather favours the interpretation of the so-called "clavicles" of *Iguanodon* as pubes. On the other hand, the ischia (*Is.* fig. 2) are also much elongated. The fore limb is very small. The bones of the manus are unfortunately scattered, but only four claws are to be found, so that possibly each manus may have had but two clawed digits. The hind limb is very large, and disposed as in birds. As in the latter class, the femur is shorter than the tibia, a circumstance in which *Compsognathus* is more ornithic than the ordinary *Dinosauria*. The proximal division of the tarsus is ankylosed with the tibia, as in birds. In the foot the distal tarsals are not united with the three long and slender metatarsals, which answer to the second, third, and fourth toes. Of the fifth toe there is only a rudimentary metatarsal. The hallux is short, and its metatarsal appears to be deficient at its proximal end.

It is impossible to look at the conformation of this strange reptile and to doubt that it hopped or walked, in an erect or semi-erect position, after the manner of a bird, to which its long neck, slight head, and small anterior limbs must have given it an extraordinary resemblance.

I have now, I hope, redeemed my promise to show that, in past times, birds more like reptiles than any now living, and reptiles more like birds than any now living, did really exist. But, on the mere doctrine of chances, it would be the height of improbability that the couple of skeletons, each unique of its kind, which have been preserved in those comparatively small beds of Solenhofen slate, which record the life of a fraction of Mesozoic time, should be the relics, the one of the most reptilian of birds, and the other of the most ornithic of reptiles. And this conclusion acquires a far greater force when we reflect upon that wonderful evidence of the life of the Triassic age, which is afforded us by the sandstones of Connecticut. It is true that these have yielded neither feathers nor bones; but the creatures which traversed them when they were the sandy beaches of a quiet sea or lake, have left innumerable tracks which are full of instructive suggestion. Many of these tracks are wholly undistinguishable from those of modern birds in form and size; others are gigantic three-toed impressions, like those of the Weald of our own country; others are more like the marks left by existing reptiles, or *Amphibia*. The important truth which

these tracks reveal is, that, at the commencement of the Mesozoic epoch, bipedal animals existed which had the feet of birds, and walked in the same erect or semi-erect fashion. These bipeds were either birds or reptiles, or more probably both; and it can hardly be doubted that a lithographic slate of Triassic age would yield birds so much more reptilian than *Archæopteryx*, and reptiles so much more ornithic than *Compsognathus*, as to obliterate completely the gap which they still leave between reptiles and birds.

But if, on tracing the forms of animal life back in time, we meet, as a matter of fact, with reptiles which depart from the general type to become bird-like, until it is by no means difficult to imagine a creature completely intermediate between *Dromæus* and *Compsognathus*, surely there is nothing very wild or illegitimate in the hypothesis that the *phylum*, or genealogical tree, of the class *Aves* has its root in the Dinosaurian reptiles; that these, passing through a series of such modifications as are exhibited in one of their phases by *Compsognathus*, have given rise to the *Ratitæ*; while the *Carinatæ* are still further modifications and differentiations of these last, attaining their highest specialisation in the existing world in the Penguins, the Cormorants, the Birds of Prey, the Parrots, and the Song-birds.

However, as many completely differentiated birds in all probability existed even in the Triassic epoch, and as we possess hardly any knowledge of the terrestrial reptiles of that period, it may be regarded as certain that we have no knowledge of the animals which linked Reptiles and Birds together historically and genetically; and that the *Dinosauria*, with *Compsognathus*, *Archæopteryx*, and the Struthious Birds, only help us to form a reasonable conception of what these intermediate forms may have been.

In conclusion, I think I have shown cause for the assertion that the facts of Palæontology, so far as Birds and Reptiles are concerned, are not opposed to the doctrine of Evolution, but, on the contrary, are quite such as that doctrine would lead us to expect; for they enable us to form a conception of the manner in which Birds may have been evolved from Reptiles, and thereby justify us in maintaining the superiority of the hypothesis, that Birds have been so originated, to all hypotheses which are devoid of an equivalent basis of fact.

EXPLANATION OF THE PLATES.

Plate XXVII.

Figs. 1, 3, 5. The *manus*, or fore-paw; the *pelvis*; and the *pes*, or hind-foot of a crocodile.

" 2, 4, 6. The corresponding parts of a swan.

" I. II. III. IV. V. The digits, commencing with the thumb or great toe:—*cp.* the carpus; *mc.* the metacarpus; *ph.* phalanges; *Il.* the ilium; *Is.* the ischium; *Pb.* the pubis; *Am.* the acetabulum; *Ts.* the tarsus; *Mt.* the metatarsus.

Fig. 7. Front view of the foot of *Iguanodon*. The metatarsal bones are not quite naturally articulated together. Reduced from the figure given by Professor Owen in the Palæontographical Society's publications.

Plate XXVIII.

Fig. 1. The left *os innominatum* of a young ostrich.

" 2. *Compsognathus longipes*, reduced from the figure given by the late Professor A. Wagner in the *Abhandlungen der k. Baierischen Akademie*. *Scp.* scapula; *H.* humerus; *R.U.* radius and ulna.

" 3. Those parts of the skeleton of *Iguanodon* which are certainly known:—*Mn.*, the mandible, is very possibly too large; all the other bones are drawn in their true proportions, as shown by the Maidstone specimen.

THE STUDY OF CHEMICAL GEOLOGY.

By David Forbes, F.R.S., etc.

In the present age of rapid intellectual progress, the field of cultivation pertaining to any branch of scientific enquiry becomes each day more and more extensive in proportion to the advance and development of the science itself.

Geology is no exception to this rule. The student who now-a-days intends to pursue this science with any chance of success, must not merely confine his labours to observation in the field, but must necessarily impose upon himself the task of acquiring at the same time, a sound fundamental knowledge of the principles of several of the collateral sciences, in order that he may thereby be enabled to understand and estimate correctly, the true value of the evidence he may collect in his travels.

It was doubtless very different in the infancy of geology, when the name "geologist" was applied to the observer, who, without any pretension to preliminary scientific knowledge, but endowed with a reasonable amount of common sense and a sturdy pair of legs, walked over the district in all directions with a map and section in his hand, upon which he coloured or noted down the relative extent, direction, and inclination of the various rocks which he encountered.

From its very nature, such work is, in great part, merely mechanical in character; and as it is well known that the best maps, whether geographical or geological, are not always the production of those most eminent in the higher branches of these sciences, it is not improbable that the intellectual powers required for the execution of such duties have occasionally been somewhat overrated.

In truth, the very existence of geology itself is dependant upon the co-operation of the allied sciences. Zoology came first to the assistance of the mere stratagrapher, and opened up a new and vast field of enquiry by insisting upon the value of palæontological evidence, and showing how sedimentary deposits, in even the most distant parts of the earth, might be co-related in geological chronology, a result which could never have been

arrived at by the mere examination of their mineral character and position in the field; mathematics and astronomy lent their aid in solving many important problems connected with the phenomena of our sphere; and mineralogy was required to determine the mineral components of which its crust was formed; whilst a knowledge of optics and the use of the microscope enables the geologist to extend his investigations far beyond the limits to which his naked eye could otherwise convey him.*

When, however, the geologist advances further, and desires to study something more than the mere external forms and physical characters of the materials of which our globe is built up, he is compelled to call in the aid of chemistry, for it is by chemical science alone that he can be enabled to demonstrate the true nature of these materials, to explain their formation or origin, or to discover the causes which have produced the changes or alterations which they have already experienced, or which they may now be undergoing.

The great importance of the application of chemistry to geology is now universally acknowledged; yet, although on the Continent much has been done of late years in this direction, it is surprising how little attention has been directed to the study of chemical geology in Great Britain.

British geologists seem to have all but exclusively devoted themselves to the consideration of the stratagraphical and palæontological succession of the sedimentary beds, and have, as a rule, studiously avoided the investigation of all geological phenomena which did not appear to admit of explanation by the agency of mere mechanical forces. At the same time, however, it is curious to observe that there have not been wanting those who have put forth vague theories to account for the nature and formation of our metamorphic and eruptive rocks, &c., hypotheses which, unfortunately, can only be regarded as flights of imagination, since it is well known that, with but some few rare exceptions, no chemico-geological investigations or chemical analyses of British rocks or of their component minerals have as yet been made which could serve as a basis for any such generalisations.

Foremost as this country is in all the other departments of geology, Great Britain must, however, be admitted to be far behind in chemical geology; so that, by directing attention to the subject, it is to be hoped that others may be incited to take up and devote themselves to this most interesting and prolific branch of scientific enquiry.

* *Vide* "The Microscope in Geology," *Popular Science Review*, vol. vi., Oct. 1867, p. 355, et seq.

In commencing the study of chemical geology, the student should, above all things, avail himself of every opportunity for experimental research, always bearing in mind, however, that geology, not chemistry, is his starting-point; and that, consequently, his laboratory must be made, as it were, subservient to his work in the field, yet at the same time go hand in hand with it.

There appears to be an innate tendency in man to take up a favourite cause or hypothesis, to which are often attributed effects in reality the result of some very different agency, or which may be due to the combined action of several causes; and for this reason the student should be particularly careful not to attach himself to any special theory or school of geology which might bias him when estimating the value of evidence brought forward on both sides of any question under consideration.

The partisans of the so-called Plutonic and Neptunic, or igneous and aqueous schools of geology, have apparently quite forgotten how difficult, if not impossible, it is, in the study of Nature's operations, to draw any sharp line of demarcation as to where any one cause ceases and another commences to operate, and have each in turn attempted to make the action of fire or water alone, account for effects which no impartial investigator can for a moment doubt, have been, at least in many cases, the result of a combination of both agencies.

Since the action of fire, water, and gases must be regarded as the most important agencies by which chemico-geological changes have been brought about in our globe, it becomes of the utmost importance that the terms igneous, aqueous, and gasolytic action, when applied in the study of geological phenomena, should be defined with some precision.

Igneous action is, in other words, volcanic action—that is, the action of heat as seen developed in active volcanoes, the study of which led to the formation of the Plutonic school of geologists. This is not a mere dry fusion, like melting lead, glass, or other anhydrous substances in a crucible, but is one in which, whilst heat plays the grand *rôle*, is in nature invariably accompanied by the action of the vapour of water and gases.

Aqueous action is the action of waters (fresh or saline) such as are seen on the present surface of the globe; and is not the mere solvent action of pure water, but is one in which the air, gases, salts, and other bodies contained in natural waters, assisted by heat, materially alters the solvent powers and chemical reactions of the water itself.

Gasolytic action is the effect of gases and vapours, more or less assisted by heat.

Al' these agencies are naturally modified by the effects of chemical action and mechanical force. In all three cases, the

actions of heat, of water, and of gases are found to be combined, each playing a more or less prominent part. Yet there can be no misunderstanding or confusing the precise meaning to be attached to each term.

In igneous or volcanic action, whilst the effects of heat predominate, the presence of heated steam and gases exercises a most important influence in modifying the results: and in this case the water present is in the form of steam.

In aqueous action, on the other hand, the water acts as a liquid, not as a vapour, and is the main agency. Yet the effects of the gaseous and solid constituents, as well as of its temperature, must be taken into full consideration.

The immense volumes of steam emitted by volcanoes during their outbursts, would naturally prepare the observer to expect that some portion might become entangled in the lava, and thus account for the microscopic cavities containing water frequently found in volcanic products; whilst at the same time he would not consider the presence of microscopic water cavities in the older rocks as proving any dissimilarity of origin, or as necessarily demonstrating them to be of aqueous formation, as has been advanced by some writers on the subject.

In like manner, when, as Bunsen and Laurent have shown experimentally in the laboratory, that hydrous silicates and borates may be formed and retain their water, even when exposed to temperatures above the melting point of silver, the student must be convinced that water can enter into and be retained in combination even at a very high heat, and probably to his surprise, finds himself driven to the conclusion, that after all, fire and water are not so antagonistic or incompatible in nature, as they at first sight would appear to be.

It is but seldom or ever that any change in the crust of our globe can be traced to any one sole cause, and it seems quite impossible for the impartial or unbiassed observer to come to any other conclusion than that most, if not all, the phenomena of nature, are due to a combination of forces, and that the same identical phenomenon may at times be the result of agencies totally different from those which at other times have given rise to its appearance.

The chemical geologist, when enquiring into the mode of formation of the mineral constituents of rock masses, must, both in the field and laboratory, soon convince himself of the truth of this assertion. Thus, taking, for example, the most widely spread of all substances, silica, he finds that he can produce it in his laboratory by many totally distinct processes: as an igneous product by the oxidation of silicon at high temperatures; as an aqueous product by the decomposition of silicates; as a gasolytic product from the decomposition of the gaseous com-

pounds of silicon with fluorine, chlorine, &c.; and it even might be regarded as an organic product, when produced from the decomposition of the silicic ethers.

His experience in the field would further provide him with abundant cases of crystallised silica or quartz, as an igneous product occurring in the lavas from volcanoes; as an aqueous product crystallised from solution, or proceeding from the decomposition of mineral silicates; as a gasolitic product in the form of tubes, evidently resulting from the decomposition of its fluorine compounds; whilst the carapaces and other parts of infusoria, &c., present silica in a form which owes its appearance to the action of organic life.

Numerous other examples might be cited to show that this is, if anything, the rule and not the exception; and the conclusion to be deduced from their study is self-evident, namely, that it is impossible to be over-cautious in attributing the formation of minerals, or of the rock masses in which they occur, to any one cause, to the exclusion of other agencies.

This must be constantly borne in mind when enquiring into the formation of minerals or rocks, and no generalisations based on single experiments should be hastily assumed as correct; for example, it is well known that a precipitate or deposit of carbonate of lime is formed when a solution of carbonate of soda is added to one of chloride of calcium, yet the chemist is not entitled to rush to the conclusion, either that all limestones had been so formed, or even that the lime which they are known to contain had ever been in the state of chloride of calcium, at least not until further investigation, both in the laboratory and field, did satisfy him that it could not have been otherwise; on the contrary, however, such an enquiry proves satisfactorily that even if, in some rare instances, limestones may have been formed by the direct precipitation of chloride of calcium by the carbonate of soda, that this is the exception and not the rule, which shows them to have been secreted by the action of organic life, from the lime salts held in solution in the ocean, and further points out how other limestones have originated in the deposition of carbonate of lime previously held in solution in water charged with carbonic acid.

Just as well might it be inferred that the beds of gypsum had been produced by a stream of sulphuric acid flowing into an ocean of lime salts, because sulphuric acid does precipitate lime as a sulphate; but it is well known that some gypsum deposits are of quite different origin to others, in some cases being merely the result of the evaporation of sea-water, which always contains a large amount of sulphate of lime; in others of the conversion, *in situ*, of limestones by gasolytic action or infiltration—whilst occasionally they may have been the result of

the reactions between compounds contained in the ocean, influenced by peculiar circumstances.

The origin and mode of formation of the various rock masses and deposits which compose the crust of the earth, is a subject for investigation which cannot but yield results of great importance in the advancement of geological enquiry.

All rocks which are as yet known may be roughly arranged under two heads—eruptive and sedimentary; and both of these classes of rocks can be subdivided respectively, into normal and metamorphic, *i.e.* those which still are found comparatively* unchanged, and those which have suffered metamorphism or alteration, brought about by either mechanical or chemical force, or by both combined.

The sedimentary strata, when comparatively unaltered, show themselves as tuffs, ashes, breccias, conglomerates, grits, sandstones, shales, clays, marls, limestones, &c., and have been all formed either by the direct destruction of eruptive rocks or of previous sedimentary beds which, in their turn, had so originated; even the lime which organic life has eliminated from the ocean to form the limestones, came, if not altogether, at least in greater part, from the same source. This has been the case even from the very oldest period, or, in other words, from the epoch of the consolidation of our sphere, since the original crust of the globe must be regarded as representing what may be termed the first eruptive or massive silicated rocks.

The study of the chemistry of the eruptive rocks becomes, therefore, a subject of special interest and importance, not only as tending to elucidate their origin and formation, but also as bearing on the nature of the sedimentary strata which, as before mentioned, have, directly or indirectly, been formed from their ruins.

In Great Britain, it must be acknowledged, there is at this present time, little or no information on this subject in print; and of the few chemical analyses of rocks which have been published, it is to be feared that many of them have been made on specimens which have not been selected with care, so as to represent the actual rock mass in question.

If the skill, time, and expense requisite in order to make even a single accurate analysis of a rock, is to be devoted to so doing, surely the first thing to be attended to is, that these should not be thrown away in vain; strange to say, a large proportion of all the published analyses of rocks, so far from being of use, are, on the contrary, worse than useless to the geologist, as they mislead him by providing him with results

* Everything in Nature appears, faster or slower, to become more or less altered.

which, however accurately they may show the chemical composition of the stone actually submitted to analysis, may at the same time quite misrepresent the composition of the rock mass as a whole; in fact, a *lithological* analysis is returned where a *petrological* analysis is required.

The terms lithology and petrology are continually misapplied and used for one another, notwithstanding that the difference between them is clearly indicated by their derivations; petrology from the Greek "*πέτρος*, a rock,"* being the study of rock masses *in sitû*, their relations, occurrence, origin, mineral character, physical structure, chemical composition, &c., whilst, on the other hand, lithology from "*λίθος*, a stone," is more properly applied to the consideration of stones or detached mineral masses not *in sitû*, blocks, boulders, pebbles, &c., such as are found in drift gravel, alluvial formations, conglomerates, &c.

A knowledge of lithology may be acquired in the cabinet, but petrology must of necessity be studied in the field. From the examination of hand specimens, the lithologist coins innumerable names to indicate mere varieties of rocks, or rather stones, the very multitude of which inclines him at last to believe in all manner of transitions and transmutations of one rock into another.

The petrologist on the contrary however, by studying rock masses on the large scale, discovers simplicity in cases where the lithologist would but eliminate confusion. By a careful examination of the rock *in sitû*, assisted by the use of his microscope and laboratory, he comes to the conclusion that all these innumerable rock species do not exist in nature as rocks, but are mere subordinate portions, altered in appearance or composition by subsequent influences.

Such alterations, or transitions as they are often called, are extremely common at the points of contact of sedimentary with eruptive rocks; thus, for example, a milstone grit or carboniferous sandstone may, near the point of contact with an eruptive rock, be found to be lithologically quartzite, similar in appearance to some of even the most ancient quartzites, whilst, petrologically considered, it is but sandstone. Again, a micaceous sandstone or a mica schist bed may, at the point of contact with a felspathic eruptive rock, become in mineral composition a gneiss from the absorption of felspar, yet it is not so petrologically; the petrologist does not base his opinion upon mere hand specimens, unless in the rare cases where they have

* Also *πέτρα*, whence the synonym Betralogy. In the, for its time, very excellent treatise on rocks—Pinkerton's "Petralogy," 2 vols. London: 1811—the distinction between Lithology and Petralogy is fully explained.

been selected with judgment so as to represent the normal rock mass.

Another example, the reverse of the above, may be given: when a diorite (an eruptive rock composed of felspar and hornblende) breaks through quartzose strata, the parts of this rock in immediate contact with the strata usually absorb more or less quartz particles, and become what the lithologist would call a syenite * (rock composed of felspar, hornblende, and quartz), and he at once would describe what he would represent as a passage of the diorite into syenite. Studying the eruption as a whole, the petrologist would have no hesitation in mapping it all as diorite, and the microscopic examination of the quartziferous portion would show him that the quartz had been entangled in, but had not crystallised out of, or in other words, not been an original constituent of the erupted rock mass. Should such a hand specimen, however, be handed over to the chemist for analysis, his results, although perfectly exact in themselves, would totally misrepresent the composition of the rock mass under consideration.

Such analyses may be of considerable value, when it is known that they are intended to represent the changes produced in rocks at points of contact with others, or to show the effects of weathering, &c., but may greatly mislead when this is not expressly pointed out to the geologist, who desires to utilise them in his reasonings.

The backward state of petrological knowledge, especially as to the chemical and mineralogical composition of rocks, is in great measure due to the method pursued in its study: in general the field geologist, quite unacquainted with chemistry, and who most probably has never paid attention even to the difference between petrology and lithology, on encountering a rock in the field knocks off any projecting corner or knob which may fall most convenient to his hammer, and sends it to the chemist for analysis. How far a geologist not versed in chemistry may be subsequently able to appreciate and utilise the results of the analysis returned to him by the chemist, is open to enquiry; but it may be safely predicted, that, either from proximity to neighbouring rocks of different character, or from the decomposition and alteration produced by atmospheric

* The word "syenite," as used by the English and French geologists, denotes a rock in which quartz is an essential component, along with felspar and hornblende. The Germans, however, apply the term "syenit" to what the English and French regard as greenstone or diorite, *i.e.* not containing quartz as a normal constituent, but composed of felspar and hornblende alone. This must always be remembered when reading German geological works, but has unfortunately been in general overlooked by translators.

influences or weathering on all surface rocks, that hand specimens so collected are not likely to turn out correct representatives of the rock mass as a whole.

A single example of this may suffice; in the last number of this Review, p. 208, will be found an analysis of the rock from an eruptive dyke in the Penrhyn quarries, North Wales, described as a greenstone, and containing no less than twenty-nine per cent. of the carbonates of lime and magnesia along with sulphate of lime. It is well known that such eruptive silicated rocks, when normal, do not contain any carbonates or sulphates whatsoever, and an inspection of the specimen showed that the carbonates found were really contained in cracks and pores in the rock, and had been of subsequent formation, proceeding evidently from the decomposition of the silicates of these bases caused by the infiltration of water containing carbonic acid. The analysis of this rock is not without value in showing the nature of the changes which do take place under such circumstances; but in order to prevent the tabulated results of this analysis leading to erroneous deductions, the rock itself should have been described as abnormal, or altered from its original condition. In the same way basalts and dolerites are often described as containing carbonate of lime, but this, as in the above case, is only a result of decomposition; and in no case have the analyses of such rocks (taken in quarries or excavations beyond the reach of such external influences) shown the presence of any carbonates, unless, as happens in the lavas of Vesuvius, they may have been fragments mechanically entangled in the silicated mass.

When it is proposed to make a chemical examination of any particular rock, it should first of all be carefully studied in the field, in order that a correct opinion may be formed as to the true nature of the rock substance itself, when uncontaminated or unchanged by external influences; a specimen may then be taken which, in some measure, will represent the actual rock mass on the large scale, although this is attended with considerable difficulty and trouble, unless (as fortunately in England is generally the case) excavations or quarries have laid bare a face of rock, and so afforded facilities for obtaining the unaltered rock itself.

The quantity required to be taken and pulverised, in order to obtain an average for analysis, must entirely depend upon whether the rock is of a fine or coarse grained texture. In the latter case, a much larger quantity must naturally be employed; it should not be pulverised in an iron mortar, as, when rocks are hard, it is found that the powder so produced will contain sufficient iron, derived from the abrasion of the mortar, to affect the accuracy of the results. The pieces should be broken up on

a steel anvil to the size of peas, then crushed in a diamond mortar, and afterwards pulverised in a wedgwood, or, preferably, in an agate mortar.

In making chemical analyses of rocks, it should always be remembered that a few exact analyses are of far more value than a host of approximative ones, so that quality should never be sacrificed to quantity.

All such rock examinations should include a careful description of the mineral constituents of the rock itself, which, if fine-grained or compact, can only be effected by making a section and submitting it to the microscope. The physical properties, as specific gravity, &c., should also be noted, as well as, of course, the relations of the rock to the general geology of its district and the occurrence of any accessory minerals disseminated in it.

It has been considered necessary to lay great stress upon all points connected with the selection and analysis of rocks, for, if these be not attended to, the labour bestowed upon them may be regarded as entirely thrown away. It cannot but be admitted that the possession of a series of accurate and trustworthy analyses of rocks is of almost vital importance to the advancement of chemical geology; and it is sincerely to be hoped that, considering the backward state of our knowledge of this subject in England, some efforts will be made to remedy this defect, and so provide correct data for advancing further research into this promising department of geology.

In bringing forward this present short and necessarily extremely imperfect attempt to introduce the subject of Chemical Geology to the notice and consideration of a wider public, it would be totally impossible, within the limits of the space at command, to treat, even superficially, of all the many important geological problems which require the aid of chemistry for their solution, such as, the distribution of the elements in the crust of the globe, the study of volcanic phenomena, the origin and nature of saliferous and mineral deposits, the metamorphism of rock masses, &c. The last of these subjects has ever been a stumbling-block to the field geologist, and has long proved to him a fertile field for speculation and discussion; and even now, notwithstanding that so much has been written in its explanation, it remains, it must be confessed, nearly as obscure and intricate as ever.

All manner of strange hypotheses to account for the metamorphosis of rocks have, from time to time, been propounded, based upon the action of fire, water, electricity, magnetism, pressure, &c.; in fact, upon everything conceivable, except upon a knowledge of the chemical composition of the rocks themselves, in their altered and unaltered condition.

In the remarks contained in the preceding pages, the main

object has been to direct special attention to what might be called the discipline or principles which should guide the student of chemical geology in his researches, so as to render him, if possible, an independent and unbiassed investigator, free from the little prejudices which are sure to cling to those votaries of the older schools who find it difficult to keep pace with the rapid strides of more modern and exact science.

PLANTS KNOWN BY THEIR POLLEN-GRAINS AND OTHER CELLS.

By GEORGE GULLIVER, F.R.S.

HAD the eminent botanical artist, Bauer, lived to extend that beautiful set of drawings, of which specimens are preserved in the British Museum, the diagnostic value of the Pollen-grains and other cells must have been earlier forced on the acceptance of botanists. But, however admirable may be the progress of systematic botany since his time, a luxuriant though uncultivated field still lies neglected in an important department; and this is the cell-biography of species. Nor, until the affinities and contrasts of the most essential structural elements of plants have been as completely shown as our present improved means of research will allow, can we hope to attain the best skill in our power for a natural classification of the vegetable kingdom.

The most essential structural element truly; for every botanist now admits that this, in one form or other, is a cell. To the history, then, of this element we may look with the hope of deriving valuable help in the formation of truly natural characters for the arrangement of plants, and this through an extension of our knowledge of their structure and physiology; and, as mentioned in the 571st page of the fourth volume of this Journal, of animals also, a remarkable example of which may be seen in the form, pointed at both ends, of the red blood-corpuscles of the pike, a cell-character in which this fish plainly differs from other and congenerous species.

As regards the vegetable world, good use no doubt has been already made of the pollen and other cells in the classification of large sections, and of the spores and other cells for the characters of smaller groups, and even species, of some of the lower orders, such as the mosses and their allies. But we have only to refer to our best systematic arrangements and floras of the Phanerogamia to discover a lamentable deficiency in the present point of view. The worthy authors seem tacitly to accept Schleiden's assertion, that systematic botany has little

more to expect from anatomy and physiology. And yet the subsequent declaration of his excellent translator, Dr. Lankester, as to the importance of the cell-biography of species, should at least have arrested the attention of our systematists; but, true and opportune as his statement surely was, it seems to have fallen with little effect.

Of the pollen, whatever may be the defects for ordinal diagnosis, it is well known that there are orders truly characterised by it; and we shall soon see that lower subdivisions, even species, may be known by the pollen-grains and other cells.

We have heard it remarked, that this subject of the cell-history of species is so immense, that no one man could ever expect to complete it. Just so. And for this very reason we wish to introduce the question to the readers of the "Popular Science Review," hoping to enlist recruits into the service of this interesting and important branch of botany. A pleasant service, too; for Nature is ever delightful, and, as one of her own poets sings,

> "Never did betray the heart that loved her,"

a truth which we must more and more confess, as we extend our researches through her works, especially into this lowly and useful but beautiful and neglected department of the pollen and other plant-cells. Let any one turn his attention to them in some of the most familiar or abject weeds, meeting him in every field and wayside at this season, and the constant size and structure, the numerous resemblances and differences, in the pollen-grains of certain orders will immediately claim his admiration. Many of these forms, as may be seen in the works of Balfour, Fritzsche, Lindley, and Hassell, have been often described and figured; while the specialities of others are either quite unknown or strangely disregarded, though they are amply sufficient to afford novel and curious characters, and even to disclose manifest and constant differences between nearly allied plants, and are, moreover, easily displayed under the microscope. The same remarks apply, as we shall presently see, to the shape, structure, size, and contents, of many other cells. In truth, it seems amazing that we have so few appeals, especially concerning species of which sufficient definitions are wanting, to characters of this kind, in our systematic books; and it is to be hoped that the interesting path now only indicated, may soon be candidly examined, if not followed, by the authors of our general and local floras.

The interest of the subject will at once be manifest, if we examine the cells of various common plants, such as are arranged close together in Professor Babington's excellent "Manual of

British Botany." For example, of the section with yellow flowers and divided leaves of the order Ranunculaceæ, we shall find the pollen-grains nearly or quite round and smooth, commonly with the usual scars, and about $\frac{1}{840}$th of an inch in diameter. Only, extending our observations to Ranunculus arvensis, a curious and remarkable exception will appear in its pollen-grains. These are very rough, have an average diameter of $\frac{1}{470}$th of an inch, being about twice the size of those of its immediate congeners; and thus, both in form and size, we very easily realise a singular difference. In short, here is a plant at once known by its pollen-grains. Then, in other sections of this same order of the Crowfoots, the pollen-grains are neither globular nor rough, but smooth and oval, and with the appearance of a slit or inflection of the membrane, reminding us of the figure of a coffee-berry. This appearance is constant; but in pure water the cell often becomes turgid and globular, when the apparent slit vanishes as if it had been originally due to a linear fold or partial collapse of the cell-wall, as is certainly the case in some other pollen-grains of this shape. But we do not see it in those of Ranunculus arvensis, and some of its near allies, although this coffee-shaped pollen-grain is common to several different orders of plants, and may be well seen, among the Ranunculaceæ, in Ranunculus Ficaria, Caltha palustris, and Trollius Europæa.

Among Leguminosæ, too, this form of pollen is well exemplified in Lotus corniculatus and L. major. Now these are two plants which are regarded by some of our most eminent botanists as nothing but varieties of one and the same species, "Lotus major being only larger in all its parts, from its moister habitat, than L. corniculatus." But our inquiries will show, on the contrary, that the pollen-grains of the smallest of these plants are the largest; for in L. corniculatus their average size is $\frac{1}{1143}$rd of an inch by $\frac{1}{1714}$th, while in L. major, they are about a third smaller, measuring only $\frac{1}{1600}$th of an inch by $\frac{1}{2666}$th. Thus these two interesting plants may be distinguished from each other by the pollen-grains; as we have figured them, with those of some of the Ranunculeæ, in Dr. Seemann's "Journal of Botany," for September 1866.

The significance of the cell-history, in the present point of view, would be much increased by an exposition of it in the plant-tissues generally. But as we cannot do this now, a few remarkable examples only will be here noticed. Compare, *e.g.*, the beautiful radiate or stellate cells of the pith of Juncus conglomeratus, J. effusus, and J. glaucus, with the oval cells of the pith of J. squarrosus and J. bufonius; when the cells of the former three species will be seen as an actinenchyma, and of the latter two as an ovenchyma, a constant and curious differ-

ence between these plants, as we have depicted it in the "Ann. Nat. Hist." for December 1863. Again, compare the spores, the tissue-cells of the fronds and involucres of Hymenophyllum Tunbridgense and H. Wilsoni, when they will be found regularly smaller in the former than in the latter fern, as shown by our engravings in Dr. Seemann's "Journal of Botany," for October 1863. And yet these two plants are often described as mere varieties of one species.

But still more notable illustrations are found in those beautiful organisms, the raphides and their cells, so fully described in the "Popular Science Review," for October 1865, that we will now only add another remarkable and unexpected proof of the validity of the views there advanced. Premising that the raphidian character is signally fundamental and universal in certain plants, *e.g.* Onagraceæ, as it is present in the seed-leaves, and pervades the greatest part of the tissues from the cradle to the grave of the species, we had long searched in vain for the exception of an ex-raphidian plant in this order, when at last a supposed one was found in Montinia. But further inquiry led to the discovery that this genus, though placed by Lindley and other eminent botanists under the order Onagraceæ, does not truly belong to it, but rather to the Saxifrages, with which its cell-structure better agrees. And thus a seeming exception became a strong proof of the rule.

And this is the only instance in which a plant not familiar to English botanists has been mentioned in this paper. For the examples of microscopical structure have been purposely confined to such as, though not to be found in the books of systematic botany, are abundant in the book of Nature, and may be easily verified in the most familiar plants, with the aid only of an achromatic object-glass of half an inch focal length. The pursuit might prove at once delightful and instructive, and could hardly fail to produce useful results; with the conviction, too, that specific details of the pollen and other cells must form an interesting and important part of any future and truthful description of the natural characters of our flora.

Fig 1

Fig 2.

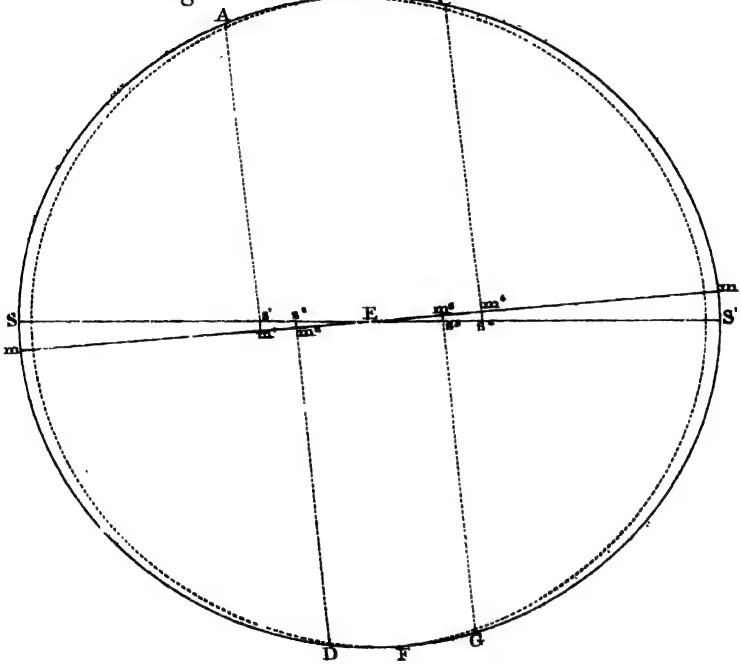


Fig 3.

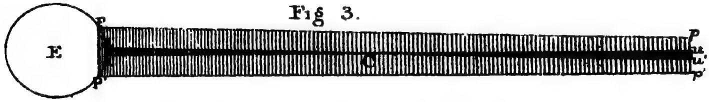
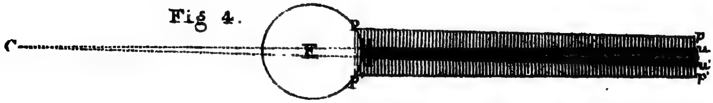


Fig 4.



Eclipses.

THE GREAT ECLIPSE OF AUGUST 17, 1868.

By RICHARD A. PROCTOR, B.A., F.R.A.S.

Author of "Saturn and its System," "Half-hours with the Telescope," etc.

A TOTAL eclipse of the sun is a phenomenon which is as instructive and interesting to the astronomer as it is impressive to the general observer. There are, indeed, few phenomena which have so largely influenced the progress of the science of astronomy as eclipses of the sun and moon. In the very infancy of the science, observant men were led by the study of eclipses to achieve the first of that long series of triumphs which have won for astronomy the title of the "exact science." Nothing but the powerful influence exerted on men's minds by the obliteration of the orb of day, whilst still high above the horizon, could have led the ancient Chaldean astronomers to pursue that long and laborious process of inquiry which resulted in their celebrated discovery of the Saros—the only ancient cycle which still has a scientific value. Nor is it easy to over-estimate the interest of the results evolved by recent astronomical researches from the records of eclipses which took place two or three thousand years ago. We see the moon's motion slowly increasing, the rotation of the earth slowly diminishing—effects which the observation of eclipses only could ever have revealed to us. In all ages of astronomy, the study of eclipses has had an important bearing on the science of astronomy; but it has only been in recent times that the observation of eclipses has led to the discovery of facts bearing upon the physical constitution of the great orb which sways the planetary system. Of late years, each successive total eclipse has attracted greater attention, and led to new physical discoveries. But the invention of a new instrument of research—the spectroscope—has led astronomers to hope yet more from the first great eclipse in the observation of which this instrument shall be made to take a part. Singularly enough, it happens that the eclipse which takes place in the present year will not only be interesting on this account, but will be in

many respects the most remarkable eclipse that has taken place within historical times, or that will take place for a thousand and more years.*

A dissertation upon the theory of eclipses would be very much out of place in these pages, even if space could be spared for it. But there are one or two points not treated of satisfactorily in most astronomical works, which require to be briefly discussed, in order that the reader may be able to understand the importance of such an eclipse as that of August 17th next.

Fig. 1 (Plate XXIX.) illustrates the general theory of eclipses both of the sun and moon. The cone, e C e′, is the shadow of the earth; so that C e, C e′ produced would touch the sun's globe. In reality, the angle e C e′ is very much smaller than it is represented in the figure: it is, in fact, about half a degree. The distance E C is variable, being as great as 870,300 miles when the earth is in aphelion, and as small as 843,300 miles when the earth is in perihelion. The moon travels round the earth in an orbit whose mean radius is 238,770 miles. Thus it is seen that the shadow of the earth extends nearly four times as far from the earth as the moon's orbit. Now it is obvious that, if the moon when in opposition—that is, towards m *m*—passes wholly or in part within the cone e C e′, she will be totally or partially eclipsed. And if the moon, when in conjunction—that is, towards m′ *m*′—falls wholly or in part within the cone m′ C *m*′, she must throw a shadow upon the earth; or, in other words, there will be an eclipse of the sun.

Now, opposite m *m*, the cone is considerably smaller than it is opposite m′ *m*′. The moon, therefore, in travelling round the earth—in a plane inclined to E C at a small angle—passes more frequently within the part of the cone opposite m′ *m*′ than within the part opposite m *m*; in other words, there are more solar than lunar eclipses.† But when the moon is eclipsed, it is clear, from Fig. 1, that she can be seen from a whole hemisphere. On the contrary, the shadow of the moon covers a com-

* It will perhaps come one day to be recorded among the coincidences which the history of science has presented, that the invention of spectroscopic analysis should have preceded, by only nine years, the occurrence of this great eclipse.

† If, however, the passage of any part of the moon through the penumbra,—represented by the shaded space between the lines e m, e′ *m*—were looked on as a partial eclipse of the moon, lunar eclipses would be slightly more numerous than solar ones. For it is easily shown that m *m* slightly exceeds m′ *m*′, since C m′, C *m*′, m e, and *m* e′, all touch the sun's globe; but the two former, proceeding from a more distant intersecting point, are inclined at a smaller angle than the two latter. However, astronomers take no notice of any lunar eclipses in which the moon's body does not pass wholly, or in part, within the true *umbra*.

paratively small portion of the earth's surface; so that a solar eclipse is not visible over any very large extent of country. Hence it happens that, in any one place, solar eclipses are far less frequent than lunar ones.

Let us next consider the motions of the sun and moon, as they would be seen by an observer supposed to be placed at the earth's centre. The sun and moon are continually circling round the celestial sphere, the sun on the ecliptic in the space of one year (the diurnal motion may be left out of consideration altogether at present) the moon, once in a sidereal lunar month, in a path which is inclined about 5° 8′ (sometimes a little more, sometimes a little less) to the ecliptic, but which is not otherwise fixed in position. The nodes of the moon's orbit, or the points in which it intersects the ecliptic, are continually shifting, sometimes advancing along the ecliptic, at other times retrograding, but on the whole retrograding at such a rate as to go once round the ecliptic in somewhat less than nineteen years.

Now if we consider these motions we shall see that, supposing the sun and moon both to start from a node, the sun will have gone some distance from the node when the moon has come round to that point, and yet a little further before the moon has overtaken him, *i.e.* before the end of one lunation. Therefore, when the two bodies are in conjunction, they are separated from each other by a slight interval. This interval has increased at the end of the next lunation; and clearly, it will first increase and then decrease, until the time comes when the two bodies are in conjunction near the other node. Were it not for the slight motion of the nodes already mentioned, this node would be half a circumference of the ecliptic from the other; but under the actual circumstances the distance is somewhat less than the semi-circumference of the ecliptic; *that is, than the distance traversed by the sun in six months.* The same is of course the case if we consider the motion of the moon with respect to the point directly opposite the sun, that is, with respect to the moving centre of the earth's circular shadow, as supposed to be projected on the interior surface of a sphere surrounding the earth at the moon's distance.

Now it is clear that, for an eclipse of the sun, the moon must, when in conjunction with the sun (that is, at the time of new moon), be close to a node. As seen from E (fig. 1) the moon must lie between m′ *m′*, the sun being supposed to lie in the direction E M. And for an eclipse of the moon, the moon must, when in opposition to the sun—that is, at the time of full moon —be also close to a node; or, as seen from E, the moon must lie within the dark part of the cone, between m and *m*. Hence, it follows, from what was shown in the preceding paragraph, that

after one epoch at which an eclipse (or more than one) of either kind has taken place, an interval of nearly six months will elapse before another eclipse (or set of eclipses) can take place.

Let S E S′ and M E M′ (fig. 2) represent the apparent paths of the sun and moon on the celestial sphere. They are, of course, great circles of the sphere, and are here supposed to be seen sideways, the two nodes being both seen at E, one between E and the eye, the other beyond E. The arcs SM, S′M′ contain each rather more than 5°. Now, suppose that on the same scale, the small lines s^1m^1 and s^4m^4 represent the greatest distance which can separate the centres of the sun and moon, so that there may be a solar eclipse (mere contact, of course, in such a case).* Then it is clear, that if conjunction takes place when the moon is on either the nearer or the farther arc represented by m^1m^4, there will be an eclipse. Let us open out the circle MEM′ until it is seen as a circle, and let one of the two arcs be opened out into the arc AC (m^1 moving along the line m^1A, m^4 along the line m^4C). The arc AC is found in this way (or rather from the calculations which result from this construction) to be at the outside 37° 12′. It varies of course with the varying distances of the sun and moon from the earth, which variations obviously affect the construction indicated in fig. 1. Its mean value is 33° 56′. As there are two such arcs, we see that whereas the whole circumference of the ecliptic contains 360°, the portions along which eclipses are possible contain on an average only 67° 52′. Reducing both arcs to minutes, we obtain the numbers 21,600 and 4,072. It follows that, on an average of any very great number of lunations, there are for every 21,600 conjunctions of the sun and moon, 4,072 at which the sun is eclipsed.

Next let us do the like for the moon. We take s^2m^2, s^3m^3, equal to the greatest distance at which the moon's centre can be removed from the centre of the earth's shadow, in order that there may be a lunar eclipse.† Thence we obtain the arc D G, whose average value we find to be 21° 47′; and as there are two such arcs, we find that along the whole ecliptic of 360° there are on an average only 43° 34′, along which a lunar eclipse can take place. Thus, for every 21,600 lunations, there are on an average 2,614 lunar eclipses.

In all, there are, for every 21,600 lunations, 6,686 eclipses, solar or lunar.

* The angle m′ E *m*′ in fig. 1 corresponds to the angle subtended by m^4s^4 at E in fig. 2—not to the angle m^4Es^4 as actually seen, but on the supposition that Em^4 and Es^4 are *foreshortened radii* of the sphere A S D S′.

† This is the distance subtended at E (fig. 1) by the section of the umbral cone opposite m *m*.

Now, suppose that, in fig. 2, S F S′ C represent the moon's orbit, the broken curve near it the ecliptic. If the sun and moon are together between A and C, but close to C, there is an eclipse of the sun, but a very small part of his disc is hidden. The moon passes in advance, and about fourteen days or so later the moon is in opposition. Now, in this interval, the sun traverses about 14°, and is therefore near to B, so that the point directly opposite to him, or the centre of the earth's shadow, is near to F. Since the moon and the earth's shadow come together near F, there is a total eclipse of the moon. Next, the sun and moon come together near to A, and there is a partial eclipse of the sun. Thus there are three eclipses in this set, and there are no more eclipses for about five months.

But suppose that the moon and the earth's shadow are together near to D, first on the side of D towards F. Then there is a partial lunar eclipse. At the ensuing conjunction, the sun and moon are together beyond B (that is, a little towards A), and there is a total or annular, or at least considerable solar eclipse. At the ensuing opposition, the moon is beyond G, and there is no lunar eclipse. Hence, there are two eclipses in this set. But if the moon had been near to D, on the side away from F, at the first opposition, the next conjunction would find the sun and moon close to B, and there would be a total or annular eclipse. At the ensuing opposition, the moon would be beyond G, and there would be no lunar eclipse. Thus, at this passage of the "eclipse-month," there would be but one solar eclipse, and that one total or annular.

A little consideration of these extreme cases will show that during the eclipse-month there may be—(1) three eclipses, in which case two are solar and partial, the other lunar and total; (2) two eclipses, in which case one or other is lunar, the other solar, and either may be total or partial (but *both* cannot be total); or (3) one eclipse, which must be solar, and total or annular.* Also note that two sets of class 1 cannot succeed each other either immediately or closely. Now there intervene rather more than 5½ months between successive eclipse-months. Hence there may be three, and must be two, eclipse-months in the course of a year. If there are three, one may be of class 1, the other two of class 2, in which case there are seven eclipses—the greatest number which can possibly take

* In this last case, the moon must pass through the *penumbra* at the epochs of full moon on either side of the solar eclipse. Thus, though the *Nautical Almanac* makes no record of the fact, the moon will be obscured by the penumbra at 11h. 52m. A.M. on August 3, and at 3h. 57m. A.M. on the morning of September 2, 1868. The former phenomenon will, of course, not be visible in England; the latter will. The obscuration will last some time.

place within the course of a single year. If there are only two eclipse-months, these may be of any of the above classes, but not both of class 1. If both are of class 3, there are only two eclipses, and both are solar and either total or annular.

Thus we see the reason of the statement commonly made without assigned cause in popular works on astronomy, that there are never less than two or more than seven eclipses, and that if there are only two, both are solar. To this we may add the rules that, if there are seven, four are solar; and that, if there are two, the moon is obscured four times in the terrestrial penumbra.

It is also evident, that the most important eclipses are likely to take place when there is a single solar eclipse during the passage of the critical period. This happens twice in the year 1868. One of these eclipses took place on February 23. It was annular, and visible so near to us as the northern parts of France. The other will take place on August 17, and will be a very remarkable eclipse. It will be visible over the regions indicated in Plate XXX.

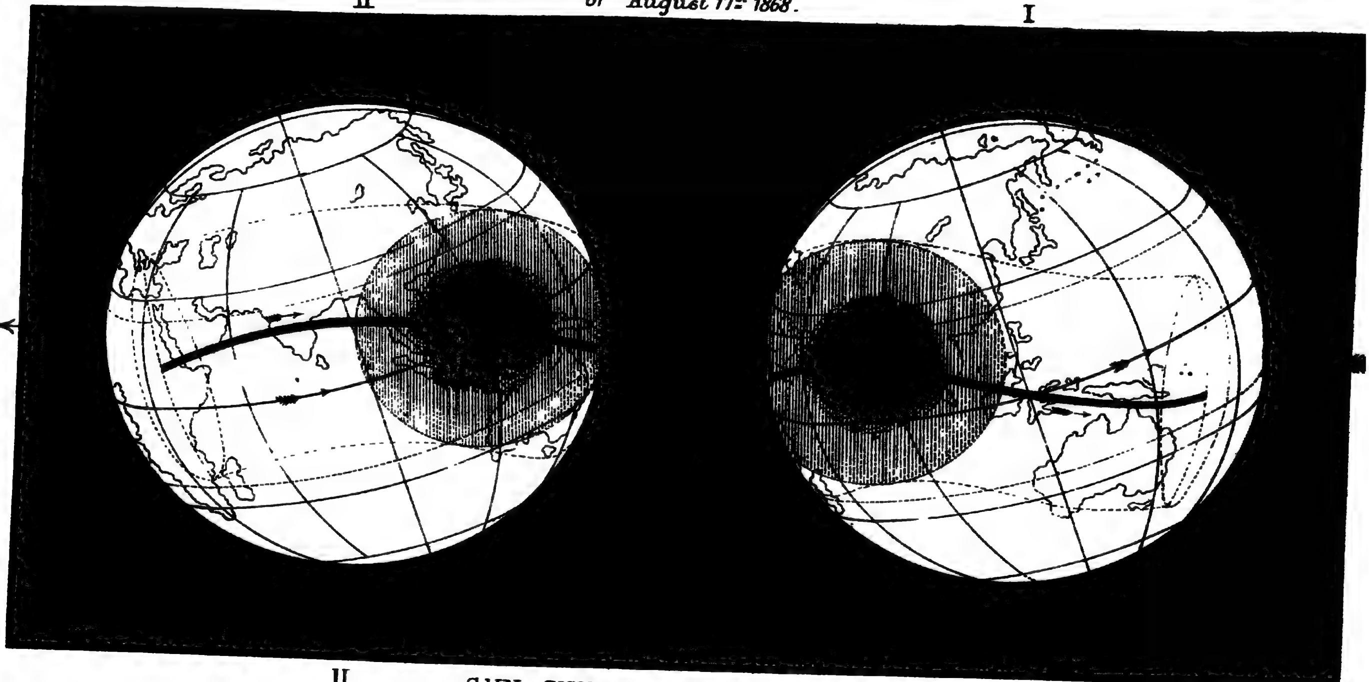
We have seen why a single solar eclipse (during the eclipse-month) is likely to be a noteworthy phenomenon. Let us next consider what other circumstances affect the magnitude of an eclipse.

The earth moves around the sun in an elliptic orbit, her greatest and least distances from the sun being respectively as 31 to 30. The moon, also, moves round the earth in an elliptic orbit, her greatest and least distances being as 10 to 9. Thus the apparent diameters both of the sun and moon are variable; the diameter of the sun varying between the values 32′36″·4 and 31′31″·8, that of the moon between the values 33′31″·1 and 29′21″·9. Thus at the epoch of central eclipse the sun may be wholly obliterated or a ring of light may be left unhidden. The extreme cases are—(1) when the sun's diameter has its greatest value and the moon's its least, in which case there will remain a ring of light 1′37″·2 wide; and (2) when the sun's diameter has its least and the moon's its greatest value, in which case the moon's disc overlaps the sun's by 59″·6 all round, and the sun continues, therefore, for several minutes wholly obliterated.

Fig. 3 shows how far the cone of total shadow reaches in the former case. c is the vertex of the cone; the lines a c *u′* and a′c *u* would, if produced, touch the lunar and solar discs. In this figure the distance a c bears its just proportion to the earth's dimensions, but the angles a c a′, *u* c *u′* are greatly exaggerated. The lines p*p*, p′*p′* bound the penumbra: and the cone a c a′ contains all points from which the sun would appear to be annularly eclipsed.

Illustrating the path of the Moon's shadow across the Earth's disc in the great Eclipse, of *August 17th 1868.*

II I



II SUN-VIEWS OF THE EARTH I

at 4 A M (I) and 6 A M (II) Greenwich Solar Time

(The Moon is supposed to be removed so that its shadow is seen)

W. West, lith.

In fig. 4, C is the point to which the cone of shadow would reach in case 2, were it not for the interposition of the earth. Uu, U$'u'$ bound the umbral, Pp, P$'p'$ the penumbral cone. In this figure, as in the former, the angle uCu' is greatly exaggerated, but EC bears its just proportion to the radius of the earth E.

If we consider that the lines Cu, Pp, Cu', P$'p'$, in both figures meet (in pairs) upon the moon's globe, we shall see that the penumbral section through C has a radius exactly equal to twice the moon's diameter. Hence clearly PP$'$ is greater in fig. 3 and less in fig. 4 than twice the moon's diameter. We see then, that in an annular eclipse the penumbra extends (*cæteris paribus*) over a wider range of country than the penumbra in a total eclipse.*

Now the greatest possible value of UU$'$ (fig. 4) can easily be determined. For the sun should be at its smallest—that is, should subtend 31$'$ 31$''$·8, and this, therefore, is the value of the angle uCu'; also it is known that EC is equal to 4¾ radii of the earth (when the moon is in perigee and the sun in apogee). Therefore it is readily seen that the arc UU$'$ is equal to 31$'$ 31$''$·8 increased in the proportion of 4¾ to 1, or as nearly as possible to 2½°. Hence the greatest radius of the circular umbra thrown on the earth, as in fig. 4, is 2½°, or about 173 miles.

But it is clear that an eclipse of this extent cannot happen once in many thousands of years, nor can one happen often which approaches even pretty closely to the conditions here required.

It is obvious that if the moon is removed by any considerable arc from her perigee, or the sun from his apogee, there will be a much smaller umbra. And there is another consideration to be noticed. The shadow does not necessarily fall, as shown in fig. 4, directly towards the centre of the earth. It might fall near P or P$'$ for example; in which case the point P and P$'$ being further from the moon than U and U$'$ the shadow would clearly be less than UU$'$ (for uCu' is a cone decreasing towards C, and p is farther from the moon than U is). In point of fact, most of the noted total eclipses have fallen far away from the equator, and thus have been less considerable than those which can take place in equatorial or sub-tropical regions.

But in the great eclipse of the present year, nearly all the conditions which tend to increase the moon's shadow are pretty closely fulfilled.

First as respects the sun's apparent diameter, which should

* It may easily be shown that PP$'$ (in fig. 3), diminished by AA$'$, is equal to PP$'$ (in fig. 4) increased by UU$'$.

be as small as possible. We have seen that the least value this element can have is 31′ 31″·8, the greatest 32′ 36″·4. On August 17 the sun's diameter will be 31′ 41″·0, or 9″·2 greater than the least and 55″·4 less than the greatest value. Of this element then we can merely say that it is favourable. But the apparent magnitude of the moon is a more important element. It should of course be as large as possible. We have seen that it varies between the values 29′ 21″·9 and 33′ 31″·1. On August 17, it will be no less than 33′ 28″·6; only 2″·5 less than the greatest value this element can have.

Then, lastly, as respects the latitude of the regions traversed by the eclipse. This should be such that the sun should rise nearly to the zenith of the place at which the eclipse is central at noon. In the present instance the sun is only 2½° from the zenith of the spot where this happens (longitude east from Greenwich 102° 50′·6, north latitude 11° 35′·7). In this region the total eclipse lasts 6m. 50s.

The last-named peculiarity of this great eclipse is illustrated in Plate XXX., which exhibits the path of the moon's shadow across the earth's disc.* This plate requires a little explanation. It serves to illustrate what is termed the *projection of solar eclipses:* in this method the earth and moon are supposed to be seen from the sun. In such a case the transit of the moon across the earth would, of course, determine the occurrence of an eclipse—since if the moon hides any part of the earth from the sun, the sun must be hidden (wholly or partially) from that region of the earth; in other words, the region must be in the shadow of the moon.

Now, there are three motions to be considered in dealing with Plate XXX. First the earth, as seen from the sun, is moving bodily from right to left at the rate of upwards of 65,000 miles per hour. This motion is indicated by the long transverse arrow. Then the earth is rotating upon her axis in such a manner that regions visible on the disc appear to be moving from left to right. This motion is indicated by the small arrow placed on the equator. Lastly, the moon apparently traverses the earth's disc from left to right, or in the same direction as that of the former motion—but at a greater rate. In fact, the apparent motion of the moon (as supposed to be seen from the sun) during the eclipse of August 17, is about twice as great as that of the equatorial parts of the earth. This motion is indicated by the small arrow beside the path of the black shadow.

* The presentation and slope of the earth's axis are deduced, with a slight variation, from Plate IX. of my "Sun-views of the Earth." The continents and oceans are, in fact, presented in almost exactly the same way in fig. II., as in the first figure of the above-named Plate.

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ABSTRACT OF THE QUINQUENNIAL REPORT OF 1864.

Since the last Division, 2,641 Policies, assuring £2,050,788, have been issued, giving an annual average of 528 Policies of £777 each—a large and steady increase of the business.

The sum of £72,702 has been received during the five years in new Premiums, being at the rate of £14,540 a year.

The total income from Premiums, which in 1859 was £182,429, now amounts to £214,104, indicating an average annual increase of £4,385, after allowing for loss of income from discontinued Policies; while the gross income from all sources has increased at the rate of £10,230 per annum.

Claims have arisen during the five years on 794 Policies assuring £624,327. and carrying Bonuses to the amount of £116,899.

In addition to the Bonuses on Policies upon which claims have arisen, the sum of £87,149 has been paid as bonus in other ways, such as in reduction of bonus liability by cash payment, reduction of premium, purchase, &c., making a total of £204,48.

In the valuation of the Assets, an ample margin has been allowed for possible fluctuation of the Funds; and in the valuation of the Liabilities, the *risk* Premiums only have been taken into account, and no profit is declared by anticipation.

The Assets, consisting of Funded Property, Mortgages, Life Interests, and Reversions, Premiums due on 31st December (since paid), Interest accrued on Investments, Balance at Bankers, and in hand, amount to £2,315,129. 19*s*. 2*d*.

The Liabilities, consisting of the values of Policies and the Bonuses already declared, claims accrued in 1863 but due in 1864, commission, taxes, and sundry small accounts, amount to £1,964,739. 1*s*. 7*d*. There is, therefore, after making provision for every known liability, a surplus of £350,390. 17*s*. 7*d*.

The Directors recommend that £329,890 of this surplus be distributed as absolute Bonus; and that the remaining sum of £20,500. 17*s*. 7*d*. be retained for the payment of annual, contingent, and conditional Bonuses.

The sum of £329,890 will produce reversionary Bonuses amounting to £506,300, yielding a percentage ranging from 5 to 34, or 9½ on the average of the sums assured; and a percentage ranging from 26 to 160, or 59½ on the average, on the premiums received in respect of which the Bonus is allotted.

The Society now assures by 9,022 Policies the sum of £7,233,564, and has an Assurance Fund amounting to £2,272,385. 11*s*., and an Annual Income of £307,475. The large number of assurances in force affords a protection to the Society against those deviations from the average which attend a paucity of numbers, while the respective amounts of the capital and the income attest the firm and satisfactory condition of the Society.

The experience of the Society during this period (the fourth which has elapsed since paying off the Shareholders), has fully realised the expectations of the Directors, and they feel assured that the Members will share their satisfaction.

By order of the Board of Directors,

OLINTHUS GREGORY DOWNES,

Actuary.

WHOLE LIFE.

WITH PARTICIPATION IN PROFITS.

TABLE No. 1 A.

EQUAL RATES OF PREMIUM.

Annual Premiums required for an Assurance of £100 for the whole Term of Life.

Age.	Annual Premium. £ s. d.	Age.	Annual Premium. £ s. d.
15	1 10 8	33	2 8 0
		34	2 9 5
16	1 11 5	35	2 10 11
17	1 12 3		
18	1 13 0	36	2 12 6
19	1 13 10	37	2 14 2
20	1 14 7	38	2 15 11
		39	2 17 9
21	1 15 5	40	2 19 9
22	1 16 3		
23	1 17 2	41	3 1 10
24	1 18 1	42	3 4 1
25	1 19 0	43	3 6 6
		44	3 9 0
26	2 0 0	45	3 11 9
27	2 1 0		
28	2 2 0	46	3 14 7
29	2 3 1	47	3 17 8
30	2 4 3	48	4 0 11
		49	4 4 4
31	2 5 5	50	4 7 6
32	2 6 8		

TABLE No. 1 B.

Annual Premium payable during *Ten Years only* for an Assurance of £100 for the whole Term of Life.

Age.	Annual Premium. £ s. d.	Age.	Annual Premium. £ s. d.
15	3 14 11	33	5 5 0
		34	5 7 1
16	3 16 5	35	5 9 5
17	3 17 11		
18	3 19 6	36	5 11 9
19	4 1 0	37	5 14 2
20	4 2 6	38	5 16 8
		39	5 19 3
21	4 4 0	40	6 1 11
22	4 5 6		
23	4 7 1	41	6 4 8
24	4 8 9	42	6 7 6
25	4 10 5	43	6 10 6
		44	6 13 10
26	4 12 1	45	6 17 4
27	4 13 9		
28	4 15 6	46	7 0 11
29	4 17 4	47	7 4 7
30	4 19 2	48	7 8 4
		49	7 12 4
31	5 1 1	50	7 16 5
32	5 3 0		

The advantages of Life Assurance may be thus briefly enumerated.

To provident persons Life Assurance presents the means of securing, by a small annual saving, a provision for their families, in the event of premature death.

It affords the opportunity of making a settlement prior to marriage.

It enables persons to raise money on life interests.

It secures sums of money contingent on parties coming of age.

It affords the opportunity of restoring to a family any amount of capital which the parent may have sunk on an estate, to hold it as tenant for life, or for two or three lives; an occurrence very common in many parts of England, particularly with respect to property held under the Church.

It affords facilities to debtors to satisfy their creditors; whilst to creditors it offers effectual, and, in many cases, the only means of security.

THE ECONOMIC LIFE ASSURANCE SOCIETY is constituted so as to afford these advantages to the public in their fullest extent, giving the advantages of the *mutual principle*, while supported by a large accumulated capital.

ECONOMIC LIFE ASSURANCE SOCIETY.

Particulars required on a PROPOSAL for an ASSURANCE.

Name, Profession, and Residence (in full) of the Party who *makes* the Assurance ....

Amount, and Term of Assurance, and by which Table

Name and Rank, or Profession, of the Person *whose Life* is to be Assured ....

Place and Date of Birth ....

Age next Birthday ....

Present Residence ....

Whether employed in any Military, Naval, or Preventive Service..............................

If resided abroad; where, and for what period? ......

If any near Relative have died of Consumption?......

If had the Small Pox, or undergone Vaccination; and which? ....

If at any time afflicted with Gout, Asthma, Spitting of Blood, Fits, Hernia, or any other disorder tending to shorten Life? ....

If the Life proposed for Assurance have been declined at any Office..............................

Reference to two persons, to ascertain the present and ordinary state of Health and Habits of the Person whose Life is to be Assured..............................

Signature of the Person whose Life is to be Assured.

If the earth were not rotating, the moon's apparent path would be approximately straight during the transit; in fact, referred to the earth's disc, it is so. But the region actually traversed by the moon does not, in either figure of Plate XXX., appear with straight edges. This is due to the earth's rotation, which brings regions within the path of the shadow, which would not otherwise be eclipsed.

We see also that the length of the region actually traversed by the black shadow, which would be a semi-circumference of the earth (in the case of an eclipse so nearly central) if there were no rotation, is diminished considerably through the effects of the earth's axial rotation.

There is an oval in each figure, and each oval is divided by a curved line into two halves. The oval in fig. II. contains all those regions over which the sun is eclipsed totally or partially at rising. We see from fig. I., that the line of country extending from the Black Sea across Africa which has just reached the visible, that is, the illuminated half of the earth's disc is in shadow; in other words the sun is partially eclipsed at rising. The upper and lower intersections of the shadow's outline with the circular boundary of the disc, mark two points at which the eclipse ends at the moment of sunrise, and these two points lie on the left-hand curve of the divided oval in fig. II. This half of the oval's boundary contains all such points. The other half contains all points at which the eclipse begins at sunrise. The dividing line contains all points at which the middle of the eclipse occurs at sunrise.

The oval in fig. I. contains all those regions over which the sun is eclipsed wholly or partially at sunset. The right-hand half contains all points at which the eclipse begins at sunset, the other contains all points at which the eclipse ends at sunset; and the dividing line contains all points at which the middle of the eclipse occurs at sunset. In this case as in the former, one figure illustrates the other; we see, for instance, that a part of the region within the oval of fig. I., is on the edge of the disc and within the shadow of fig. II.; that is, is partially eclipsed at sunset. The points of intersection of the shadow's outline with the edge of the disc in fig. II. indicate, of course, points at which the eclipse begins at sunset.

The region traversed by the eclipse could hardly have been better suited than it actually is, for the purposes of observation. Had it occupied any other part of the tropics, as the Pacific Ocean, the South American Continent, or Africa, it would not have been easy to supply skilled European observers in sufficient number, nor instruments of adequate power. If it had fallen much farther north or south, again (still lying within the tropics), the difficulties of observation would have been largely increased.

As it is, there are many points along the line of central eclipse which are conveniently accessible. It passes close to Aden, and nearly coincides with the track followed by our steamers between Aden and Bombay. By a singular coincidence two mail-steamers, one from Aden for Bombay, and the other from Bombay for Aden, will pass through the black shadow. A third steamer from Bombay on August 18 will be starting nearly at the time of total eclipse. But the most important part of the shadow's path is that which traverses the Indian peninsula. I shall follow Major Tennant's account of this portion of the line of central eclipse. He has "computed for the whole breadth of the Indian peninsula the central line and the limits of totality." He writes: "The central line enters on the west coast of India, in latitude 16° 35′, passing near Muktul and Guntoor, and a little north of Masulipatam. The shadow is about 143 miles broad. The northern limit passes close to the town of Sholapoor (which is accessible by rail from Bombay), about twelve miles north of the large city of Hydrabad in the Dukhun, and eighteen miles north of Rajamundri, at the head of the delta of the Godaveri. The southern limit lies eight miles north of Goa, or twenty miles south of the station of Belgaum, twenty miles south of Bellary, twenty-four south of Kurnoul, and seventeen south of Ongole. It includes thus the stations of Kolapoor, Belgaum, Kurnoul, Sikunderabad, Ongole, Guntoor, Masulipatam, and Rajahmundri, besides some smaller ones; the whole course of the Kistna, its delta, and that of the Godaveri, and parts of the valleys of the Bhema and Toongabudra lie within these limits. Leaving India proper, the shadow crosses the Bay of Bengal, includes the north Andaman Island, and then passes through the Mergui Archipelago and the province of Tenasserim, across the Malay peninsula to the island of Borneo (including on its way part of the promontory S.W. from Saigon), which it reaches between our colony of Labuan and the Sarawak country, and eventually through Torres Straits. Of this course," adds Major Tennant, "the west coast of India will be experiencing the south-west monsoon. The same state of things exists at the Andaman Islands and on the British side of the Malay peninsula. The other side is not easily attainable, and I am not aware that there would be any inducement to go to Borneo. The eastern part of the track through India affords, I believe, every chance of fine weather, and I think observers would do well to select that part."

The duration of totality at points along the line of central eclipse across the Indian peninsula will be from 5 m. on the western coast, to 5 m. 50 s. on the eastern coast. In the eclipse of 1860 the duration of totality was far less than this, and our observers in Spain had in no instance more than 3½ minutes

during which to observe the phenomena which are presented during total eclipse. It is also obvious that, in the middle of the totality, the obscurity will be far greater than in the eclipse of 1860, since the extent by which the moon's disc extends beyond that of the sun will be nearly twice as great. We may, therefore, hope that important information will be derived from the observation of this great eclipse, respecting the inter esting phenomena which attend the total obscuration of the sun; and, in particular, it is to be hoped that something will be learned respecting the nature of those coloured prominences and floating masses which become visible round the moon's disc. It is possible that changes which may be in progress in the figure or position of the prominences may be detected by a comparison of views taken by different observers; since a considerable interval will elapse between the passage of the shadow over the western and eastern parts of the Indian peninsula.

It is satisfactory to learn that two expeditions, well provided with instruments, have proceeded to India from England for the purpose of observing the great eclipse.

The first, organised by Major Tennant, has been sent out under the auspices of the Royal Astronomical Society. "An application was made to the India Office, to bear the expense of establishment and instrumental means." For photography, a silvered glass reflector has been provided. Three men of the Royal Engineers have been trained at Mr. Delarue's Observatory at Cranford, in the processes of taking small negatives, enlarging, and etching them on glass. The reflector, of 9¼ inches diameter, is a Newtonian, and is mounted equatorially and driven by clockwork. Mr. Browning has devoted much time and care to the construction of this instrument, and has been assisted by Mr. Delarue's advice and experience; in other words, all that science and skill could devise to render the instrument perfect has been applied to its construction. A telescope belonging to the Astronomical Society has been provided for spectroscopic researches, and one of the Greenwich telescopes has been adapted to the polarization apparatus.

The second expedition has been sent out by the Royal Society under Lieutenant John Herschel, a son of Sir John Herschel. Lieutenant Herschel has received instructions "to confine his attention to observations of the spectra of the corona and red prominences." He is provided with an equatorial telescope, five inches in aperture, for spectrum observations. Another telescope, three inches in aperture, has been provided for observations for polarized light. Lastly, "four hand spectrum-telescopes, of the form constructed by Mr. Huggins for the observation of meteors, have been sent for use by observers stationed at different places along the central line of the eclipse."

The French Government has sent out M. Jansen, at the head of a well-appointed expedition. A Prussian observing party has also been sent out to Aden. The Pope sends out the Jesuit priest and astronomer Father Secchi. A plan was formed for an expedition of Dutch observers, who were to view the eclipse from some part of the Dutch East Indian possessions; but we understand that this plan is not likely to be carried out, having been formed too late to enable all the requisite preparations to be made. Mr. Pogson, the superintendent of the Madras Observatory, will head a third English expedition. He has been supplied by Mr. Huggins with spectroscopes and instruments for observing the polarization of light from the corona and coloured prominences.

It will be a great disappointment to all who take interest in the science of astronomy if unfavourable weather, or other unforeseen circumstances, should interfere with the success of these well-appointed expeditions. If all should go well, we may look for results of extreme interest and importance. Information respecting the quality, movements, and variations of figure of the coloured prominences around the solar disc can hardly fail to be of great value to the students of solar physics. The examination of the corona also promises results of interest. And it is just possible that in an eclipse of this magnitude something may be learnt of the nature and habitudes of the zodiacal light in the neighbourhood of the sun's body.

ON THE RANGE OF THE MAMMOTH.

By W. Boyd Dawkins, M.A., F.R.S.

Fossil remains of the elephant have attracted the notice of man from the days of Alexander the Great down to the present time. Theophrastus, the son of a fuller of Lesbos and a pupil of Aristotle, was the first to put the discovery of fossil ivory and bones * on record, his attention having most probably been given to the neighbouring ossiferous deposit of Upper Lydia, whence the country people, some five hundred years afterwards, obtained tusks which Pausanias describes as horns.† During the last three centuries many curious stories were framed to account for the presence of the large fossil bones and teeth in Northern and Central Europe. In 1577 Professor Felix Pläten ‡ of Basel, constructed out of some elephantine remains that were found in Lucerne, the drawing of a giant nineteen feet high, which the Lucernois adopted as a supporter in their coat of arms. This amazing discovery of a nameless giant was excelled by that made in 1613 near St. Antoine. An elephant's skeleton from that place was exhibited in Paris as having been found in a tomb thirty feet long, on which was engraved in Gothic characters, "Teutobochus Rex," and as belonging therefore to the Cymbrian chief of that name who fought against Marius. The imposture was exposed by M. Riolan, after a controversy almost as famous as that over the Moulin Quignon jaw. Even so late as 1645 a skeleton of an elephant found near Crems in Austria with "a head as big as a middle-sized table" and with "the bone of his arm as big as a man's middle," was considered to be of human origin. Dr. Behrens, the quaint author of the "Natural History of the Hartz Forest," argues that this cannot be true, because of its large size; § "for the tallest man we know of was Og of Basan, whose bed is said in Deuteronomy, chap. iii., to have been eighteen feet long; now, allowing the bed to be but one foot longer than the man, he

* De Lapidibus, p. 298, line 9.

† Attic. lib. i. cap. xxxv.

‡ Cuvier Oss. Goss. t. 1, art. Elephas.

§ Page 25.

was seventeen feet high. But if the head and tooth found by the Swedes had belonged to a regularly proportioned man, he must have exceeded Og by a vast deal; for the tooth is said to have weighed five and a half pounds; and supposing that of a common man to weigh half an ounce, which is too much, then the giant must have had an height answerable to a hundred and seventy-six times the bulk of a middle-sized man." In the eighteenth century the "Ebur fossile," or "Unicornu fossile," was used freely by the German doctors as an absorbent, astringent, and sudorific, until the discovery of the bone caves of the Hartz, when it became too abundant to pass any longer for the true unicorn, and lost much of its repute in the eyes of the common people.

When at last these giant remains were recognised as belonging to elephants, it became fashionable to account for their presence in Europe on the hypothesis that they were introduced by the hand of man. Hannibal was supposed to have imported them into France and the Val d'Arno, during his famous invasion of Italy. In Germany the Romans were held responsible for them as far as the Elbe, while the scattered remains found near Aachen were ascribed to the elephant presented by the Calif Haroun al Rashchid to Charlemagne. In Britain a molar tooth found in Huntingdonshire in the first quarter of the eighteenth century, and preserved in the Sloane Museum, was actually quoted by Dr. Küper as that of the identical elephant brought over by Cæsar, to which animal he attributes all the other remains found in our island. But we must pass over the many attempts to grapple with the problem, which necessarily proved abortive from the defective state of the physical sciences. The great Russian savant, Dr. Pallas, was the first to give a systematic description of the Mammoth; Dr. Blumenbach to assign to it the name of *Elephas primigenius*; and Dr. Falconer to distinguish it from the three other species with which it had been confounded. An enquiry into its range involves considerations of the deepest interest, relating to the climate which its presence connotes, to the causes that led to its extinction, and to the ancient physical geography of both the new and the old worlds. Its distribution through space will first of all engage our attention.

Throughout the length and breadth of England and Wales the Mammoth is the most common fossil in both caves and river-deposits. In Yorkshire, Wales, and Somerset, it formed part of the prey of the hyænas, and was frequently dragged by them, piecemeal, into their dens. The circumstances under which it occurs in river deposits are shown in the brickfield at Ilford in Essex, at least as well as in any other in Britain. In the spring of 1868 the writer of this essay accompanied Mr.

Antonio Brady to the Uphall pit. At the top there was the surface soil from one to three feet deep, then an irregularly stratified layer of brickearth and gravel six feet; and lastly, an irregular layer of flint gravel, underneath which was a fine reddish gray sandy loam, four feet thick. All these had been cleared away, leaving a platform exposed, on which was a most remarkable accumulation of bones carefully left *in situ* by the workmen. On the right hand was a huge tusk of Mammoth, eight feet long, with the spiral curvature undisturbed by the pressure of the superadjacent strata. Across it lay a remarkably fine antler of red-deer. At a little distance was the frontal portion of the skull of an Urus, with its horncores perfect to the very tips, while around bones of various animals were scattered—of horse, *Rhinoceros hemitœchus*, Mammoth, urus, either brown or grizzly bear, and wolf. As we gazed down on this tableau we could not doubt for a moment, that the bottom of an ancient river with all its contents lay before our eyes—a river in which all these animals had been drowned, and by which they had been swept into the exact position which they then occupied. This inference was confirmed by the examination of the thin layer of sandy gravel on which they rested, for it was full of the shells of *Corbicula fluminalis*, with the valves together just as in life. There were also specimens of the common Anodon of our rivers, and of the *Helix nemoralis* of our hedgerows. On a continuation of the same platform, now cut away, the skull of Mammoth was discovered in 1864,* perfect, with the exception of the tusks which had been broken away with their incisive alveoli. That of the right-side lay twenty feet away from the skull, while the left has not yet been discovered. Owing to the surprising skill of Mr. Davies, the skull and tusk were taken up and reunited, and now constitute by far the finest specimen of Mammoth in the British Museum. In some cases the Mammoth remains have not been deposited by a river. At Lexden † near Colchester, as the Rev. O. Fisher well observes, they were overwhelmed in a bog, the small bones of the feet being found in their natural position, a fact which shows that they sank feet foremost through the peat into the subjacent clay.

The Mammoth remains in Britain exhibit various stages of decay, and for the most part have lost their gelatine. There are, however, some few exceptions that remind us of analogous cases in Siberia. A tusk dredged up off Scarborough was so slightly altered that it was sawn up and divided among the fishermen, to be applied to the ordinary

* "Geological Magazine," No. v. p. 241.

† In "Quart. Geol. Journal," vol. xix. p. 393.

purposes for which ivory is fitted. One segment fell into the hands of Mr. Fitch of Norwich.* Dr. Buckland also chronicles a similar discovery on the coast of Yorkshire, where the tusk was sufficiently hard to be used by the ivory turners.† In Scotland there are three instances on record of a similar preservation of the ivory. Two tusks were found in 1817 at Kilmaurs, Ayrshire, and a third at Clifton Hall, between Edinburgh and Falkirk in 1820. The latter weighed twenty-five and three-quarter pounds, and was sold to an ivory turner in Edinburgh for £2, and sawn asunder for the manufacture of chess-men, but the parts were rescued from that fate by falling into the hands of Sir R. Maitland Gibson.‡

The Mammoth is extremely rare in Scotland as compared with England, probably because the greater part of the former country was covered with glaciers at the time that the post-glacial mammals dwelt in Europe. In Ireland § also, owing probably to the same cause, its remains have been found but in two places, at Magherry in 1815, and in a cave at Shandon in 1859. Its presence at all in that island implies that, during the post-glacial period, Ireland formed part of the main land of Europe.

The animal ranged through France, and southwards across the Alps as far as Rome, where it has been identified by M. Lartet and Dr. Falconer ‖ in the collection made by MM. Ponzi and Ceselli. Its remains are found in the volcanic gravel bed of Ponte Molle and Monte Sacro, a fact which shows that it dwelt within the Papal dominions at a time when the volcanos of central Italy were in full play, and the site of the imperial city was occupied by currents of lava and masses of volcanic tufa. It is almost unnecessary to say, that the volcanos became extinct at a time far away out of the reach of history. In Spain the Mammoth has not yet been discovered. In Germany it is most abundant. At Seilberg near Constadt ¶ on the Necker, a group of thirteen tusks and some molar teeth were found in 1816, "heaped close upon each other, as if they had been packed artificially." A similar discovery was made in the same year in the loam at the village of Thiede, four miles to the south of Brunswick. In a small heap of ten feet square there were eleven tusks, one eleven, and another fourteen and three-quarter

* Owen, Brit. Foss. Mam. p. 247.

† Reliquiæ Diluvianæ, p. 179.

‡ Wernerian Trans. vol. iv. p. 58.

§ Journ. Geol. Soc. Dublin, Feb. 10, 1864.

‖ Lartet, Bull. Soc. Géol. Franc. 2e sér. tom. xvi. p. 505. Falconer, "Palæontographical Memoirs," vol. ii. p. 241.

¶ Reliquiæ Diluvianæ, 4to. second edition, 1824, pl. xxiv.

feet long; thirty molar teeth, and many large bones, one of which, according to Mr. Bieling, measured six feet eight inches. "Mixed with these were the bones and teeth of rhinoceros, horse, ox, and stag; they all lay mixed confusedly together; none of them were rolled or much broken; and the teeth, for the most part, separate and without the jaws: there were also some horns of stag." In both these cases the great accumulation of remains in one spot, is owing to their having been drifted together by eddies in the stream in which the the animals were drowned at some point higher up, as in the parallel case afforded by the brick pit at Ilford. In European Russia, as in Germany, the Mammoth is very abundant. Its remains in the auriferous gravels of the Urals,* prove that it dwelt in that region at the time those gravels were being deposited. Its head-quarters, however, are to be sought in the northern regions of Siberia, where it must have lived in countless herds for a vast period.

The store of fossil ivory laid up in that desolate area is practically inexhaustible, the tusks preserved by the cold having been an article of trade to the Jakuti and Tungusians time out of mind, and exhibit no signs of a falling off in the supply. In 1803 the famous Adams Mammoth was discovered at the mouth of the Lena, with its flesh so well preserved in the ice in which it was imbedded, that it was for the most part eaten up by bears, wolves, and dogs; fortunately Mr. Adams was able to obtain the whole skeleton, now in the museum at St. Petersburg, with the exception of a hind leg, which had probably been dragged away by the bears. He also obtained proof that the animal was clad in hair and wool, and had a long shaggy mane. The eminent Siberian explorer Dr. Middendorf,† in 1843, met with a second instance of the Mammoth being preserved to such a degree that the bulb of the eye is now in the same museum as the Adams skeleton. It was found in latitude 66° 30′ between the Obi and Yenesei near the arctic circle. In the same year he also found a young animal of the same species in beds of sand and gravel, at about fifteen feet above the level of the sea, near the river Taimyr in latitude 75° 15′, associated with marine shells of living arctic species, *Nucula pymæa, Tellina calcarea, Mya truncata*, and *Saxicava rugosa*, and the trunk of the larch (*Pinus larix*). The fourth and by far the most important discovery of a body is described by an eye-witness of its resurrection; so valuable in its bearings that we translate it at some length. A young Russian engineer, Benkendorf by name, employed by the Government in a survey

* "Geology of Russia in Europe," p. 492.

† Lyell's "Principles of Geology," 9th edition, p. 81.

of the coast off the mouth of the Lena and Indigirka, was despatched up the latter stream in 1846, in command of a small iron steam cutter. He writes the following account to a friend in Germany * :—

"In 1846 there was unusually warm weather in the north of Siberia. Already in May unusual rains poured over the moors and bogs, storms shook the earth, and the streams carried not only ice to the sea, but also large tracts of land thawed by the masses of warm water fed by the southern rains. . . . We steamed on the first favourable day up the Indigirka; but there were no thoughts of land, we saw around us only a sea of dirty brown water, and knew the river only by the rushing and roaring of the stream. The river rolled against us trees, moss, and large masses of peat, so that it was only with great trouble and danger that we could proceed. At the end of the second day, we were only about forty wersts up the stream; some one had to stand with the sounding rod in hand continually, and the boat received so many shocks that it shuddered to the keel. A wooden vessel would have been smashed. Around us we saw nothing but the flooded land. For eight days we met with the like hindrances until at last we reached the place where our Jakuti were to have met us. Further up was a place called Ujandina, whence the people were to have come to us, but they were not there, prevented evidently by the floods. As we had been here in former years, we knew the place. But how it had changed! The Indigirka, here about three wersts wide, had torn up the land and worn itself a fresh channel, and when the waters sank we saw, to our astonishment, that the old river bed had become merely that of an insignificant stream. This allowed me to cut through the soft earth, and we went reconnoitring up the new stream, which had worn its way westwards. Afterwards we landed on the new shore, and surveyed the undermining and destructive operation of the wild waters, that carried away, with extraordinary rapidity, masses of soft peat and loam. It was then that we made a wonderful discovery. The land on which we were treading was moorland, covered thickly with young plants. Many lovely flowers rejoiced the eye in the warm beams of the sun, that shone for twenty-two out of the twenty-four hours. The stream rolled over, and tore up the soft wet ground like chaff, so that it was dangerous to go near the brink. While we were all quiet, we suddenly heard under our feet a sudden gurgling and stirring, which betrayed the working of the disturbed water. Suddenly our jäger, ever on the look-out, called loudly, and pointed to a singular and unshapely

* Dr. A. von Middendorff's Siberische Reise. Band iv. Theil ii. Erste Lieferung: Die Thierwelt Siberiens, p. 1082. St. Petersburgh. 4to. 1867.

object, which rose and sank through the disturbed waters. I had already remarked it, but not given it any attention, considering it only drift wood. Now we all hastened to the spot on the shore, had the boat drawn near, and waited until the mysterious thing should again show itself. Our patience was tried, but at last, a black, horrible, giant-like mass was thrust out of the water, and we beheld a colossal elephant's head, armed with mighty tusks, with its long trunk moving in the water, in an unearthly manner, as though seeking for something lost therein. Breathless with astonishment, I beheld the monster hardly twelve feet from me, with his half-open eyes yet showing the whites. It was still in good preservation.

"'A Mammoth! a mammoth!' broke out the Tschernomori, and I shouted, 'Here, quickly! chains and ropes!' I will go over our preparations for securing the giant animal, whose body the water was trying to tear from us. As the animal again sank, we waited for an opportunity to throw the ropes over his neck. This was only accomplished after many efforts. For the rest we had no cause for anxiety, for after examining the ground I satisfied myself that the hind legs of the Mammoth still stuck in the earth, and that the waters would work for us to unloosen them. We therefore fastened a rope round his neck, threw a chain round his tusks that were eight feet long, drove a stake into the ground about twenty feet from the shore, and made chain and rope fast to it. The day went by quicker than I thought for, but still the time seemed long before the animal was secured, as it was only after the lapse of twenty-four hours that the waters had loosened it. But the position of the animal was interesting to me; it was standing in the earth, and not lying on its side or back as a dead animal naturally would, indicating, by this, the manner of its destruction. The soft peat or marsh land, on which he stepped thousands of years ago, gave way under the weight of the giant, and he sank as he stood on it, feet foremost, incapable of saving himself; and a severe frost came, and turned him into ice and the moor which had buried him; the latter, however grew and flourished, every summer renewing itself; possibly the neighbouring stream had heaped over the dead body, plants and sand. God only knows what causes had worked for its preservation; now, however, the stream had brought it once more to the light of day, and I, an ephemera of life compared with this primeval giant, was sent here by heaven just at the right time to welcome him. You can imagine how I jumped for joy.

"During our evening meal, our posts announced strangers, a troop of Jakuti came on their fast, shaggy horses: they were our appointed people, and were very joyful at sight of us. Our company was augmented by them to about fifty persons. On

showing them our wonderful capture, they hastened to the stream, and it was amusing to hear how they chattered and talked over the sight. The first day I left them in quiet possession, but when, on the following, the ropes and chains gave a great jerk, a sign that the mammoth was quite freed from the earth, I commanded them to use their utmost strength and bring the beast to land. At length, after much hard work, in which the horses were extremely useful, the animal was brought to land, and we were able to roll the body about twelve feet from the shore. The decomposing effect of the warm air filled us all with astonishment.

"Picture to yourself an elephant with a body covered with thick fur, about thirteen feet in height, and fifteen in length, with tusks eight feet long, thick, and curving outward at their ends, a stout trunk of six feet in length, colossal limbs of one and a half feet in thickness, and a tail, naked up to the end, which was covered with thick tufty hair. The animal was fat, and well grown; death had overtaken him in the fulness of his powers. His parchment-like, large, naked ears, lay fearfully turned up over the head; about the shoulders and the back he had stiff hair, about a foot in length, like a mane. The long, outer hair was deep brown, and coarsely rooted. The top of the head looked so wild, and so penetrated with pitch (und mit Pech so durchgedrungen), that it resembled the rind of an old oak tree. On the sides it was cleaner (reiner), and under the outer hair there appeared everywhere a wool, very soft, warm, and thick, and of a fallow-brown colour. The giant was well protected against the cold. The whole appearance of the animal was fearfully strange and wild. It had not the shape of our present elephants. As compared with our Indian elephants, its head was rough, the brain-case low and narrow, but the trunk and mouth were much larger. The teeth were very powerful. Our elephant is an awkward animal; but, compared with this Mammoth, it is as an Arabian steed to a coarse, ugly, dray horse. I could not divest myself of a feeling of fear, as I approached the head; the broken, widely-open eyes gave the animal an appearance of life, as though it might move in a moment, and destroy us with a roar. . . . . The bad smell of the body warned us that it was time to save of it what we could, and the swelling flood, too, bid us hasten. First of all we cut off the tusks, and sent them to the cutter. Then the people tried to hew the head off, but notwithstanding their good will, this was slow work. As the belly of the animal was cut open the intestines rolled out, and then the smell was so dreadful that I could not overcome my nauseousness, and was obliged to turn away. But I had the stomach separated, and brought on one side. It was well filled, and the contents in-

structive, and well preserved. The principal were young shoots of the fir and pine; a quantity of young fir cones, also in a chewed state, were mixed with the mass. . . . . As we were eviscerating the animal, I was as careless and forgetful as my Jakuti, who did not notice that the ground was sinking under their feet, until a fearful scream warned me of their misfortune, as I was still groping in the animal's stomach. Shocked I sprang up, and beheld how the river was burying in its waves our five Jakuti, and our laboriously saved beast. Fortunately, the boat was near, so that our poor work-people were all saved, but the Mammoth was swallowed up by the waves, and never more made its appearance."

This most graphic account affords a key for the solution of several problems hitherto unknown. It is clear that the animal must have been buried where it died, and that it was not transported from any place further up stream, to the south, where the climate is comparatively temperate. The presence of fir in the stomach proves that it fed on the vegetation which is now found at the northern part of the woods as they join the low, desolate, treeless, moss-covered tundra, in which the body lay buried—a fact that would necessarily involve the conclusion that the climate of Siberia, in those ancient days, differed but slightly from that of the present time. Before this discovery the food of the Mammoth had not been known by direct evidence. The circumstances under which it was brought to light enable us to see how animal remains could be entombed in the frozen soil without undergoing decomposition, which Baron Cuvier and Dr. Buckland agreed in accounting for, by a sudden cataclysm, and Sir Charles Lyell by the hypothesis of their having been swept down by floods, from the temperate into the arctic zone. In this particular case the marsh must have been sufficiently soft to admit of the Mammoth sinking in, while shortly after death the temperature must have been lowered so as to arrest decomposition up to the very day on which the body arose under the eyes of M. Benkendorf, in the unusually warm year of 1846, when the tundra was thawed to a most unusual depth, and converted into a morass, permeable by water. Had any Mammoths been alive in that year, and had they strayed beyond the limits of the woods, into the tundra, some would, in all human probability, have been engulphed, and, when once covered up, the normal cold of winter would suffice to prevent the thaw of the carcases, except in most unusual seasons, such as that in which this one was discovered. Probably, many such warm summers intervened since its death, but as it was preserved from the air, they would not accelerate putrefaction to any great degree. In this way the problem of its entombment and preservation may be solved by an appeal

to the present climatal conditions of Siberia. The difficulty of accounting for the presence of such vast quantities of remains in the arctic ocean, and especially in the Läehow Islands, off the mouth of the Lena,* is also easily explained by this discovery, as well as the association of marine shells with the remains of Mammoth. The body was swept away by the swollen flood of the Indigirka, along with many other waifs and strays, and no doubt by this time is adding to the vast accumulation in the Arctic sea. It was seen by a mere chance, and must be viewed merely as an example of the method by which animal remains are swept seaward. In all probability the frozen morass, in which it was discovered, is as full of Mammoths as the peat bogs of Ireland are of Irish elk, and have been the main source from which the Arctic rivers have obtained their supply of animal remains.

But the Mammoth, in ancient days, was not confined to the old world. In Eschscholtz Bay,† it lies imbedded in a fluviatile peaty deposit, that rests on the summit of a cliff of pure blue ice, from thirty to sixty feet thick, along with the reindeer, bison, horse, and musk-sheep. Thence its remains are scattered through Canada, Oregon, and the Northern States, as far south as the Gulf of Mexico, affording abundant proof of its existence with the mastodon, on the margins of the swamps of Ohio and Kentucky.‡

Such was the range of the animal in space, in the old world, throughout the vast area north of the Pyrenees, the Tiber, Caspian Sea, and Altai mountains; in the new, from the Arctic ocean down as far south as Texas. Its presence in what are now insulated portions of the earth's surface, proves the magnitude of the geographical changes that have taken place. During its lifetime, Ireland and Britain must have formed part of the mainland of Europe, and a solid bridge of land must have connected America with Asia, by way of Behring's Straits and the Aleutian Isles. On no other hypothesis can its introduction be accounted for.

We have now to discuss the range of the animal in time. According to M. Lartet,§ it was living in Northern Siberia during an epoch corresponding to the European pliocene, whence it migrated, westwards and southwards, after the emergence of the drift-covered plains of western Russia from beneath the glacial sea. According to Dr. Falconer,‖ it lived

* Wrangel's "Siberia and Polar Sea," trans. by Major Sabine, 1840. Introduction, p. 132, 133.

† Falconer, "Palæontological Memoirs," vol. ii.

‡ "Zoology of H.M.S. Herald," pp. 1–8.

§ Comptes rendus, 1858, p. 409.

‖ "Palæontological Memoirs," vol. ii. pp. 164, 170, 198, 240, 244, 277. It

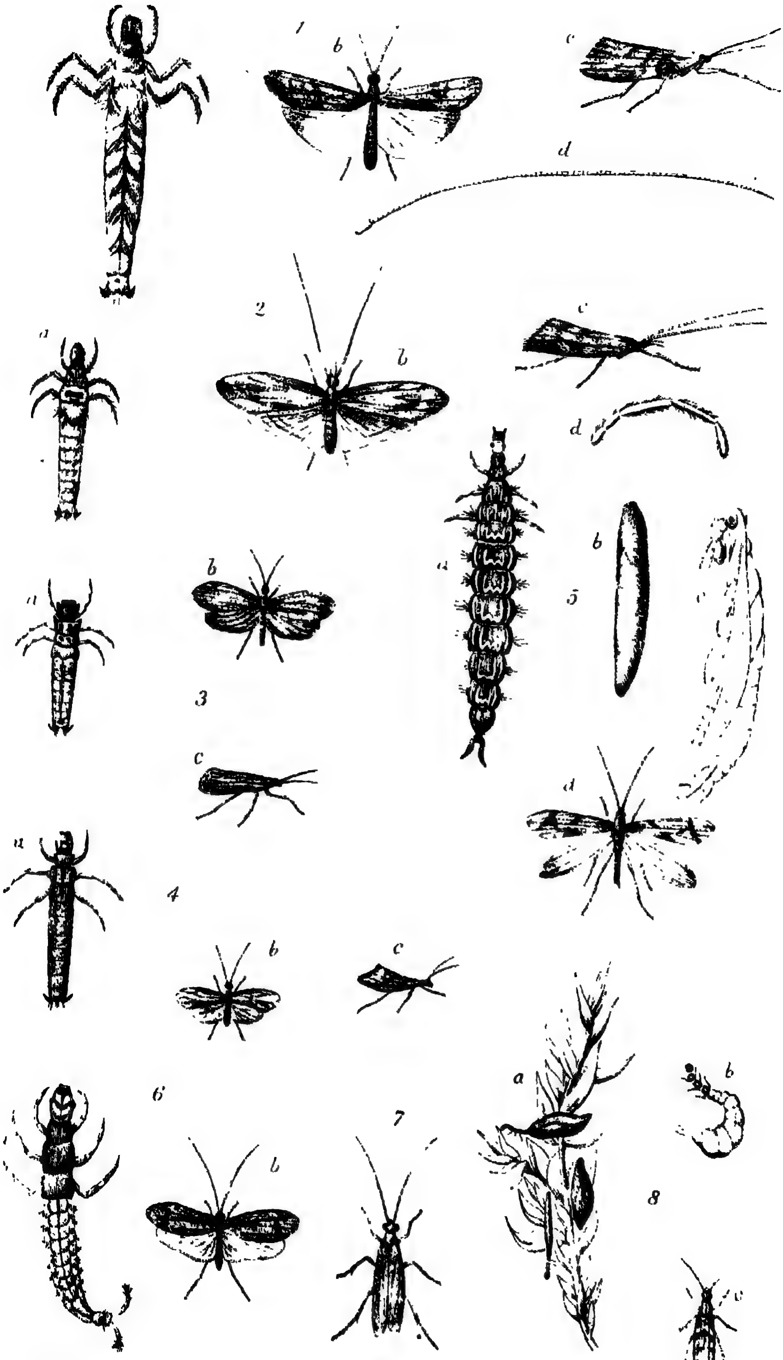
in Europe before the glacial epoch, his opinion being based upon certain remains obtained from the Norfolk coast, by Miss Gurney, the Rev. S. W. Kring, F.G.S., and the Rev. John Gum, F.G.S., none of which were found *in situ*. Their pre-glacial age is assumed from their being encrusted with small patches of peroxide of iron, which strongly resemble those on the specimens of the forest bed. That the presence of this is of no value, I have conclusive evidence before me, as I write, in a fragment of bottle glass, imbedded in feruginous matrix, picked up at Walton, and indistinguishable from that on a jaw of *R. etruscus*, from the forest bed of Lowestoft. The inference, therefore, must inevitably follow, that the peroxide of iron on the Mammoth remains cast up by the wave is no guide to their *gisement*, and consequently that the evidence adduced in favour of the preglacial age of the Mammoth in Britain, is altogether valueless. In Britain, as in the continent of Europe, the Mammoth is characteristic of post-glacial times. In Siberia, and America, it is very probable that it lived both before its appearance in, and after its departure from Europe.

The problem of its extinction now comes before us. It abounded in post-glacial Europe, while, before the dawn of the pre-historic epoch, it had vanished away. This cannot be accounted for by geographical changes, by which its habitat became restricted, and by which, consequently, the competition for life between it and the other herbivores grew more severe, because of the vast area left comparatively intact in northern Asia and America. Nor does an appeal to climatal change help at all, for there is clear proof that the animal possessed a great elasticity of constitution. In the Siberian woodlands it fed on the Scotch fir; in the swamps of Kentucky it was surrounded by the vegetation of the temperate zone, identical with that now living in the same spot. In the valley of the Tiber, also, we cannot suppose that it would be subjected to the severity of an Arctic winter. M. Lartet's explanation, that it disappeared "en conformité sans doute des lois qui, en réglant la longévité des individus, limitent en même temps la durée des espèces,"* leaves the problem unsolved, and hampered with a very wide question, as to whether the life of a species obeys the same laws as that of an individual. It is, however, by no means difficult to be grappled with. The same cause that has banished the brown bear and wolf from Britain, the bison and urus from Germany, the dinornis from New Zealand, is adequate, also, to

will be seen, by the comparison of these passages, that Dr. Falconer was by no means certain of the exact horizon of the Mammoth.

* Comptes rendus, 1858, p. 413.

destroy the Mammoth. The large size of the animal would preclude its concealment, and the increase of man would imply a corresponding destruction of animals for food. That it was hunted by the reindeer folk, in France, is proved by its remains, and especially by the rude drawing in outline, in the caves of the Dordogne. It is therefore extremely probable that it became gradually extinct, because it was hunted down for food by man. No other explanation will satisfy all the conditions of the case.



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CADDIS-WORMS AND THEIR METAMORPHOSES.

By Rev. W. Houghton, M.A., F.L.S.

It is a pleasant morning in the month of July, the wind is in the south-west, warm and gentle, the sun is nicely overcast, and everything betokens good sport at our trout-stream. Numerous flies well-known to the angler-naturalist are on the wing; here we see the merry dance of some of the smaller kinds of *Ephemeridæ*, such as *Baëtis* and *Cloëon*, now ascending with head erect, now sinking gracefully down with their two extended thread-like appendages at the end of the tail; now and then a water-moth (*Phryganea*) flits across with its characteristic zig-zag mode of flight, so like that of a butterfly, and lights on some sedge or alder fringing the river side. How delightful it is to wander along the bank of a river abounding in trout, and how pleasant the sensation of a good fish tugging and leaping for his life! And even if the fish won't rise, and you try fly after fly in vain, still there is something indescribably charming on the bank of the rippling stream—

> Where may we find the music like the music of the stream?
> What diamond like the glances of its ever-changing gleam?
> What couch so soft as mossy banks, where, through the noontide hours,
> Our dreamy heads are pillowed on a hundred simple flowers?
> While through the crystal stream beneath we mark the fishes glide
> To the sport that we court by the gentle river side.

If the fish will not rise, there is still plenty to observe; underneath the stones of the brook lie concealed various larval and nymphal forms of insect life. Let us turn over some stones and catch a few of them. Here we see a small worm-like form, with strong head and jaws, six feet, and seven pairs of branchial filaments attached to the segments of the body; this is the larva of the Alder or Orl-fly of the angler (*Sialis lutrarius*). The perfect insect deposited its eggs in May and June, on the aquatic plants near the water's edge; these, when hatched, dropped into the water, and the little things we see are this year's tender larvæ. Now we find various other larvæ,

such as those of the *Ephemeridæ* and *Perlidæ*. We notice, too, numerous habitations of the larvæ of the *Phryganeidæ* or caddis-flies. On the present occasion, let us confine our attention to these last-named insects.

The insects belonging to the family of *Phryganeidæ* (order *Trichoptera* of some entomologists) derive their name from the Greek word φρύγανον, "a faggot," or "dry stick," in allusion to the bits of stick of which the larvæ very frequently make their habitations. This method of constructing their cases, in which the larvæ and nymphæ reside, appears to have been noticed as early as Aristotle, who says: "There is a small worm-like creature, called *Xylophthorus*; its variegated head extends beyond its case, its feet are at the upper extremity, as in other worms; the rest of the body is contained in a case made of a substance like a spider's web, around and outside of which are chips of wood, so that the animal walks about with this attached to it. These creatures are attached to their cases as an oyster to its shell; the whole of the case is joined to the worm, and does not fall out of it, but can be drawn out, as if they grew together. If anyone pulls off the case the animal dies, and becomes as helpless as a snail without its shell. As time advances this worm becomes a chrysalis like a caterpillar, and lies without motion; but the nature of the winged creature that is produced from it has not been ascertained." *

This family has been studied by De Geer, who entered somewhat minutely into the details and structure of the insects belonging to it; but he did not succeed in tracing more than five species through their different states. He has given figures of a variety of cases, including several perfect insects. Réaumur and Rösel have also given drawings and descriptions of a few species with their transformations; but nearly all the insects of the group whose larvæ these authors have figured belong to one genus alone, that of *Phryganea*. Passing over the names of other naturalists, whose researches have helped to throw light on the history of the *Phryganeidæ*, we come to that of M. Pictet, whose valuable memoir "Recherches pour servir à l'histoire et à l'anatomie des Phryganides," has been spoken of as being "one of the most perfect monographs ever published." M. Pictet has published other valuable memoirs on the *Ephemeridæ* and *Perlidæ*, two families belonging to the order *Neuroptera*. This naturalist detected about 120 species of *Phryganeidæ* in Switzerland alone, and noticed the preparatory states of not fewer than fifty-two, only seven in their early stages having been previously observed by De Geer.

Professor Westwood gives the following characteristics of the

* "Hist. An.," v. 26, § 2.

order *Trichoptera*:—Wings four, membranous; the anterior generally pilose, with branching nerves; the posterior larger, and folded when at rest; prothorax very short; tibiæ with long calcaria at the tip, and often beyond the middle of the limb in the four posterior legs; mouth unfitted for mastication; mandibles rudimental; larva hexapod, ordinarily residing in a case formed of various materials, in which it retains its station by means of two hooked anal processes; pupa incomplete, inactive during the greater period of its existence.

The larvæ of those species which live in movable cases, fix them to some substance just before they assume the pupa condition; the two open extremities are then closed with a network fence, of a form differing according to the species. Food is now no longer required; respiration is effected by means of currents of water passing through the gratings. Réaumur asserts that he distinctly saw this gratework to move in alternate motion from convex to concave, as the water passed out and in. In some cases the pupæ are contained within a double envelope, the inner one being a thin membranous covering, the outer one being made of small stones. Fig. 5 *b* represents one of these inner cases, drawn from a specimen common in brooks and streams; it is the *Rhyacophila vulgaris*. The pupæ at the close of this condition are very like the perfect insects. Like the larvæ, they are provided with external respiratory filaments; but we may notice a few brownish patches on some of the dorsal segments of the abdomen. These, under a microscope, show recurved hooks, and no doubt their function is to assist the pupæ in escaping from their cases. "The pupæ of the larger species creep out of the water, crawling up the stems of plants, &c., and undergo their final change in the air; but the smaller ones merely come to the surface, where they shed their pupæ skin in the same manner as gnats, their old envelope serving them as a raft."

All the larvæ of the *Phryganeidæ* are aquatic; most of them pass this stage of their existence in movable cases of various materials and forms; but others are enclosed in non-movable cases. The materials out of which the different cases are constructed are bits of stone, sand, wood, grass, leaves, the tenanted and untenanted shells of various fluviatile molluscs. The cases are, for the most part, cylindrical, and open at each end. The fragments of stick, small angular pebbles, &c., which the larvæ use in the construction of their habitations, are held and cemented by means of a sticky secretion, drawn out in the form of long delicate silky threads spun from the mouth, as in caterpillars. Of these important organs I will speak by-and-by. Sometimes one meets with cases made of sand, having on either side long slender pieces of stick or rush:

the cases are in some instances prettily curved; these are made of fine sand. Some larvæ arrange their materials of stick or straw transversely; others employ the same materials, but arrange them longitudinally. I am of opinion that, as a rule, each species of *Phryganeidæ* arranges its materials according to a uniform pattern, but that numerous exceptions occur in this particular, depending upon a change of locality. A species, for instance, that dwells in the almost still pools under the banks of a rivulet, would form its case of light materials; but if the same caddis-worm were to be deprived of its house, and placed in the current of a gently running stream, it is very likely that the larva would build a heavier dwelling-house, suitable to the change in its position. Various experiments have been tried on the caddis-worms, with a view to ascertain the materials they would make use of in the construction of their houses, and the modes of employing them. In the "Intellectual Observer" (vol. v. p. 307–317), the reader will find a very interesting account, by Miss Smee, of caddis habitations. The authoress, after denuding some worms of their cases, placed in the vessel of water which contained them various materials, such as coloured glass, cornelian, agate, onyx, brass filings, coralline, tortoiseshell, which the worms were able to convert to their architectural purposes; figures of several of these artificially constructed cases may be seen in the plate which acccompanies Miss Smee's account.

Some writers have maintained that when the case becomes too small for the larva, it quits it and forms a new one; but M. Pictet says that it adds fresh materials of an enlarged diameter at the aperture, cutting off a portion of the opposite end. The larvæ of the *Phryganeidæ* differ slightly, according to the species to which they belong; in general appearance they are of a cylindrical form, fat and fleshy, a delicate mouthful, no doubt, for a hungry fish; the cases they inhabit are a protection to their naked body, and save them from becoming the prey of many fish. A voracious trout, however, does not scruple to swallow house and tenant together. I have frequently found the *débris* of their habitations in the shape of gravel and bits of wood in the stomachs of trout. The head is firm and horny, with strong mandibles, often notched at the tips. The larvæ have no antennæ. The eyes are small, and apparently composed of points at the side of the head, without reticulations. The thorax consists of three segments, each of which carries a pair of legs; those of the anterior segment, or *prothorax*, are shorter and stronger than the others. In some of the members of this family, as in the *Phryganeæ* proper, one notices between the anterior pair of legs a small conical projection, or horn, which Réaumur thought was a spinneret; but

as some other species, which spin silken threads, are destitute of this organ, it is hardly likely that this organ has the function attributed to it by Réaumur. The fleshy abdomen consists of nine segments, upon the first of which there are three conical tubercles, two lateral and one medial; at the end of the last segment, which is smaller than the others, there are two movable appendages of variable form; in the true *Phryganeæ* these appendages are small hooks, by means of which the animals attach themselves firmly to their cases. In the case of those larvæ which reside in immovable houses, these anal hooks are elongated and placed upon long footstalks. Numerous filaments, of various forms, beset the abdominal segments of these larvæ; sometimes they are arranged in tufts, sometimes they are isolated. A microscopic examination soon reveals the function of these membranous filaments; they are organs of respiration. Some species are destitute of external gills, the respiration being effected by spiracles on each side of the abdominal segments. Let us look at the internal organs of a caddis-worm. We will select a specimen of *Phryganea fusca* for examination: this is a common species, and builds a house of small stones, or sand, to which are attached, longitudinally, long pieces of twigs, rush, or grass, &c.; being of large size, the anatomy is easily made out. We remove the larva out of his house by making, with the point of a fine pair of scissors, a slit all the way from the one extremity to the other, and then fold back the margins; next we give the caddis a dose of chloroform to smell, and then pin him down on our dissecting trough, one pin being fixed through the thorax, the other through the anal extremity: on making a cut from one end to the other, and pinning back the sides, we notice a long thick black tubular body, which is a portion of the intestinal track coloured by food; a little care will enable us to disentangle it from the surrounding viscera, with a view to a detailed examination. The alimentary canal is a long straight tube, without any circumvolutions, passing from the mouth to the anus. M. Pictet draws attention to the absence of circumvolutions, as being remarkable in an animal whose food is solely of a vegetable nature; he considers that the shortness of the tube is amply compensated by its diameter, which is considerable. It is quite certain, however, that the larvæ of *Phryganeæ* are not exclusively vegetable feeders. I have known them devour worms, and the larvæ of other insects, and Miss Smee fed her specimens on pieces of "uncooked meat, which they would eagerly seize, and ravenously devour." I am also able to confirm the same lady's statement that these larvæ devour the mollusc *Dreissena polymorpha.* The intestinal track consists of œsophagus, crop, stomach, the small and large intestines, and the cœcal ap-

pendages; the œsophagus extends from the mouth to about the third ring of the thorax, it is without folds, and surrounded at the upper part by the œsophageal ganglionic ring, gradually leading to the crop, from which it is separated by a small, thick, circular valve. The crop, or ventricle, extends from the third segment of the thorax to between the fifth and sixth of the abdomen, is very extensible, and is frequently found greatly distended with dark food; it has numerous transversal, nearly equidistant, folds, discernible by the naked eye, and several longitudinal muscular fibres; at the bottom of the crop are inserted the hepatic vessels. The intestines are short, occupying the seventh, eighth, and ninth abdominal segments; they consist of two parts, the upper portion corresponds to the small intestines in other animals, and is very short; it is separated, by a little valve, from the large intestines, and is without folds; the large intestines are three times the diameter of the small ones, and occupy the eighth and ninth segments. The five biliary appendages are very fine and of considerable length; they enter the intestinal canal at the bottom of the crop, and are generally whitish or rose-coloured, forming a labyrinth of entangled threads.

The respiratory apparatus of the larva of a *Phryganea* consists of two large lateral tracheal trunks, which give forth numerous branches to the different parts of the body, supplying air to the muscles and the viscera; if a portion of the muscular flesh be cut away, or if it be pressed between two bits of glass, we may see a tracheal filament or two entering each external branchial appendage. The circulatory system probably differs in no essential respect from that of many other larvæ, but it is extremely difficult to make out with satisfaction. On opening a larva we notice two long bright tortuous threads, of considerable diameter, situated below the intestinal tract, and terminating in a cœcum; these threads double on themselves three or four times, and extend to about the fifth segment of the abdomen; towards the anterior portion of the body they become of small diameter, and passing along the sides of the œsophagus, open out into the mouth. These are the vessels that secrete the silky substance by means of which the larvæ cement together the materials which form their abodes. When the larva has assumed its pupa condition these secreting organs disappear.

The perfect insects make their appearance in the spring, summer, and autumn, at which latter season great numbers may be seen near every stream and pond. Most of the species are small, or of moderate size, seldom more than two inches in the expanse of wings. Their mode of flight, as a rule, is after a zig-zag fashion, and some fly with considerable activity; some species may be seen rising above the surface of the water in

groups, after the manner of gnats. "From the weak structure of the mouth," Professor Westwood observes, "it is evident they can live but a very short time in the perfect state, taking no nourishment, and only anxious to continue their species." The same naturalist states that the females deposit their eggs in a double gelatinous mass, which is of a green colour, and is retained for a considerable time at the extremity of the body; the mass is subsequently attached to the surface of some aquatic plant, and Mr. Hyndman has observed the female of *Phryganea grandis* creep down the stems of plants under the water very nearly a foot deep, for the purpose of depositing its ora. "On being disturbed, it swam vigorously beneath the water to some other plants; its bundle of eggs was found to be of an oblong form, bent in the middle, and the two ends attached to the tail of the animal." I may here remark, that a few summers ago I distinctly saw a female of the small and very common dragon fly (*Agrion*) deliberately enter the water, and run down the stem of some water plant, no doubt for the purpose of depositing her eggs. Ordinarily, however, these dragon flies alight on some aquatic weed, as on the leaf of a potamogeton, and bending their long pliable bodies under it, there lay their eggs. I am thus enabled to confirm Mr. Patterson's account, which describes the female *Agriones* entering the water for ovoposition (see "Ent. Transact." i. p. 82, app.) Westwood thinks that the genus *Phryganea* forms the connecting link between the *Lepidoptera* and the *Neuroptera*; several naturalists, indeed, consider this family to belong to the Neuropterous order; but Professor Westwood is inclined to think they have their strongest affinities with the *Lepidoptera*. "Not only," he says, "are the veins of the wings arranged upon the plan of the Lepidopterous wings; the general habit of the insects, the structure of the legs, coxæ, calcaria, and mandibles, as noticed by Kirby, and indeed, the general rudimental form of the mouth being similar; and what is more important, the internal structure of the larvæ, as noticed by De Geer, agrees with that of the Lepidopterous larvæ rather than with the *Neuroptera*." The usual colour of the insects of this group is grey, or brown; according to Westwood, a few only from extra-European countries have been brought to England; some of these exotic species are ornamented with spots and markings.

The genera of the perfect insects are thus distinguished:—

Phryganea (Latr.) has the maxillary palpi of moderate size and slightly pubescent; those in the male three-jointed, the last ovate; the antennæ of moderate size, equal in length to the wings; the anterior wings with transverse nerves in the wings, the inferior wings folded.

The following table, given by Pictet, will show the characters

of the larvæ of seven out of the eight genera which, according to that author, constitute the family of *Phryganeidæ* :—

d in a	With a circular opening	Thoracic segments rounded	External organs of respiration isolated, legs moderate		Phryganea
			External organs of respiration in bundles	Hind legs, long	Mystacida
				Ditto, short	. Sericostoma
		Thoracic segments with the front angles pointed			Trichostoma
	Opening with a slit				. Hydroptila
Larvæ not enclosed in a movable case	The pupa enclosed in a double envelope.				. Rhyacophila
	The pupa enclosed in a single envelope .				. Hydropsyche

Mystacida * (Latr.), maxillary palpi very long and very pubescent, with five joints in both sexes; antennæ longer than the wings; anterior wings straight and elongated, with a few transverse nervures; posterior folded; antennæ setaceous.

Trichostoma † (Pictet), maxillary palpi three-jointed in the male; the terminal joint club-shaped and clothed with hair; antennæ with basal joint hairy; anterior wings without transverse nervures, clothed with short thick hairs; posterior wings small and moderately folded.

Sericostoma ‡ (Latr.), maxillary palpi of the male dilated in the form of a spoon, uniting to form a rounded muzzle; antennæ large, with basal joint long and thick; anterior wings without transverse nervures; posterior small, and slightly folded.

Rhyacophila § (Pictet), maxillary palpi short, slightly pubescent, with five joints in both sexes, terminal joint ovoid, antennæ moderately long, slender, anterior wings without transverse nervures; posterior narrow, slightly folded; abdomen frequently terminated by horny appendages.

Hydropsche ‖ (Pictet), maxillary palpi with five joints in both sexes, the last long, filiform, often equalling the four others; antennæ as long as the wings, slender; anterior wings without transverse nervures; posterior wings much folded.

* From the Greek μύσταξ, "a moustache," in allusion to the pubescent palpi.

† From θρὶξ, τριχὸς, "a hair," and στόμα, "a mouth," in allusion to the pubescent joint of the maxillary palpi in the male.

‡ From σηρικός, "silken," and στόμα, "a mouth."

§ From ῥύαξ, "a stream," and φιλέω, "I love."

‖ From ὕδωρ, "water," and ψυχὴ, "a butterfly."

Psychomyia * (Latr.), maxillary palpi with five joints in both sexes, the last long and filiform; antennæ moderate; anterior wings slender, pointed, without transverse nervures; posterior wings slender and without folds similar to anterior ones. The larvæ of this genus were not known to Pictet.

Hydroptila † (Dalman), maxillary palpi with five joints in both sexes, the last ovoid; antennæ short, at least as thick at the extremity as at the base; anterior wings slender, bristling with hairs; posterior wings not folded, of same form as anterior ones.

Attention to the above characters, which distinguish the larvæ and perfect insects, will, it is hoped, be of service in aiding the student to determine at least the genus of any insect or larva he may meet with. For the identification of species he must have recourse to the admirable memoir of M. Pictet already referred to.

EXPLANATION OF PLATE.

FIG. 1. *a*, larva of *Phryganea pellucida*; *b, c*, perfect insect; *d*, antennæ.
„ 2. *a*, larva of *Mystacida cylindrica*; *b, c*, insect; *d*, maxillary palpus of male.
„ 3. *a*, larva of *Trichostoma fuscicorna*; *b, c*, insect.
„ 4. *a*, larva of *Sericostoma macula*; *b, c*, insect.
„ 5. *a*, larva of *Rhyacophila vulgaris*; *b*, inner membranous case of pupa; *c*, pupa; *d*, insect.
„ 6. *a*, larva of *Hydropsyche atomaria*; *b*, insect.
„ 7. *Psychomyia annulicornis.*
„ 8. *a*, larvæ, in case, of *Hydroptila pulchricornis*, crawling off a fragment of water-moss; *b*, larva detached from its case; *c*, insect.

* From ψυχή and μυῖα, "a fly." † From ὕδωρ and πτίλον, "a wing."

REVIEWS.

LYELL'S PRINCIPLES OF GEOLOGY.*

IT would be impossible to find a more convincing proof of the progress of scientific discovery than that which is afforded by a comparison between the last and the present edition of Sir Charles Lyell's great treatise. Nor would it be easy to obtain a better proof of the thoroughly philosophic tenour of the author's mind, than that which is evinced in the surprising candour with which he confesses alterations of opinion in accordance with the more perfect light of scientific truth. Anything, indeed, more characteristic of the modern school of science it would be hard to find than the mode in which our greatest geologist handles the numerous complex and abstruse problems which are involved in the record of our earth's history. That the author has spared neither time nor pains in bringing his best work up to the standard of existing knowledge will be evident from even the few additions and alterations which we propose to indicate. As to reviewing this work, the idea would be simply absurd; in the first place, the space demanded for such a task would be beyond the limit at the disposal of even a *Quarterly Reviewer*, and, in the second place, we should much doubt the possibility of finding anyone really competent to the task. We propose, therefore, to confine ourselves to pointing out, as briefly as we can, some of the many novel features of the new edition of the *Principles of Geology*. At the date of the ninth edition, thirteen years ago, the doctrine of progressive development, as then proposed, was in ill odour. Mr. Darwin had not offered his lucid exposition of the theory of natural selection to the public, and Professor Huxley had not distinctly lent his support to any special hypothesis of the origin of species. It was not surprising, therefore, that at that time Sir Charles Lyell's opinions on the point were at best immature. Not so now, however. In this edition it occurs to us that the ninth chapter is the most striking and important part of the work. It has been completely rewritten, and contains definitively expressed views. The author urges many arguments in favour of the theory of progressive development. He shows us how, even regarding the fossil floræ, the evidence is in favour of progression, since the oldest known flora was characterised by a great predominance of cryptogamous life. "The almost entire want," he says, in the Devonian and Carboniferous Floræ, "the first which geology has

* "Principles of Geology, or the Modern Changes of the Earth and its Inhabitants." By Sir Charles Lyell, Bart., M.A., F.R.S. Tenth, and entirely revised edition; 2 vols. London: Murray, 1868.

yet revealed to us, of plants of the most complex organisation, is very striking, for not a single dicotyledonous angiosperm has yet been found in any primary formation, and only one undoubted monocotyledon, although these two great divisions taken together form four-fifths of our living vegetation." Further, he points out that though conifers, cycads, and ferns existed in abundance in the Triassic, Oolitic, and Lower Cretaceous periods, the plants which now characterise our flora seem not to have come into existence, or to have been extremely rare, before the Upper Cretaceous epoch. Turning to the animal kingdom, Sir Charles is equally forcible in his observations. He is by no means carried away by the theory, but carefully examines the facts, and in doing so shows us that the argument from the successive groups of fossil mollusca is of little use to the progressive evolutionist. "On the whole," he says, "it cannot be said that the successive development in the course of past ages, of higher and more complex structures, is by any means conspicuous in that grand branch of the animal kingdom which is most largely represented in a fossil state." Not so, however, with vertebrates. The failure of the palæontologist to detect a single bone of any aquatic vertebrate animal, in rocks older than Murchison's Ludlow formation "is a fact of no small weight in favour of progressive development." The difficulty presented in the instance of the Ganoid fishes, which appeared first, and whose organisation appears to be of a higher order than that of the Teleostei, is not overlooked, but Sir Charles calls attention to these important points:—(1) That the persistent character of the notochord of these fishes is a mark of degradation, and (2) that the possession of a heterocercal tail is an indication of the retention of an embryonic condition, or, in general terms, a sort of arrest of development. In speaking of the class of reptiles, Sir Charles refers to the very important fact that some of the fossil groups are of a higher order than the types now in existence, so that we have in this instance, "an example of a class which gradually advanced till it reached a culminating point from which it has ever since been retrograding." So, on the author travels through the birds and mammalia, till he comes to the monkey of the Eocene, *Arctocyon primævus*. He finally draws a decided conclusion in the following lines:— "We have been fairly led, by palæontological researches, to the conclusion that the invertebrate animals flourished before the vertebrate, and that in the latter class, fish, reptiles, birds, and mammalia, made their appearance in a chronological order, analogous to that in which they would be arranged zoologically, according to an advancing scale of perfection in their organisation."

Of the other new points in the edition, we may refer to the author's examination (Chap. XI.) of the proofs of former vicissitudes in climate, derived from the study of secondary and primary fossiliferous formations; and also to the thirteenth chapter, which is nearly entirely new, and in which he discusses the very remarkable theories as to changes of climate which have recently sprung up in connection with the suggestions of astronomers as to variations in the eccentricity of the earth's orbit, changes in the obliquity of the ecliptic, and various phases of the precession of the equinoxes. In this chapter the author does ample justice to the speculations of Mr. Croll. Finally, we would refer to the large amount of additional

matter (Chapters XXXV., XXXVI., and XXXVII., of vol. ii.), in which Sir Charles Lyell fully adopts Darwin's view of the origin of species, and gives one of the best summaries of the theory of natural selection, and the arguments in favour of it, which we have yet seen. The *Principles of Geology* is a work which is too well known to need any commendation from us, and we can only say that if there are any of our readers unacquainted with it they should no longer remain in so benighted a condition. No man who desires to have broad views of natural phenomena should be unfamiliar with the most charming, most philosophic and truthful romance of nature which has ever been written.

RELIQUÆ AQUITANICÆ.*

PROFESSOR RUPERT JONES continues his editorship of the materials collected by the late Henry Christy, and the fifth part of the fine memoir on the pre-historic remains of Périgord is now before us. In this number the editor continues his description of the geology of the Vezère, and gives an account of certain of the smaller caverns. He also inserts a letter from Mr. Anderson, on the similarity of the implements found in the caves of Dordogne, to some of those used by the North American Indians. This is a most interesting contribution, and as one of the readers of the work we beg to offer Professor Jones our hearty thanks. He also quotes from a *Journey to the Northern Ocean*, by Samuel Hearne, a book published in Dublin, in 1796, a valuable record of the habits of the "Western dog-ribbed Indians." This tribe, at the period spoken of, had no knowledge of iron, their weapons being manufactured exclusively from bones, teeth, horns, and stone. Several good wood-cuts are here intercalated with the letterpress. The plates in Part V. are of their usual scientific and artistic excellence. Four of them represent flint weapons, and the fifth is a view of Le Moustier on the Vezère, from a sketch by Mr. W. Tipping, and shows the hill with its caverns, one of which latter was examined by Messrs. Christy and Lartet. This is a landscape from the press of that enterprising lithographer Mr. Vincent Brooks, and forms a very pretty picture. When the work is complete, it will form the handsomest and most perfect monograph of its kind in any language.

RAMBLES OF A NATURALIST.†

IT is no proof of Mr. Collingwood's fertility of invention, that he should have given his book the title under which—correctly or not—the trans-

* "Reliquæ Aquitanicæ, being contributions to the Archæology and Palæontology of Périgord." By Edouard Lartet and Henry Christy. London: Baillière, April 1868. Part V.

† "Rambles of a Naturalist on the Shores and Waters of the China Sea." By Cuthbert Collingwood, M.A., M.B. London: John Murray, 1868.

lation of one of M. Quatrefage's books has been published in this country. Still the name very aptly expresses the character of the work, and perhaps on this score the author may be forgiven. Indeed, all through the work we note the author's tendency to ramble, and though he touches on a goodly number of highly important questions in Biology, he does so in so sketchy a manner that not one of his essays partakes of that character of completeness which is so very desirable in scientific contributions. Pleasant discursive jottings of one who, not a professed naturalist, is a lover of nature, with enough of special knowledge to enable him to distinguish the peculiar from the common, are always enjoyable. From this stand-point, Mr. Collingwood's production is a most readable book. Its style is free and yet concise, and its descriptions of tropical scenery are excellent. The author's travels were made in China, Formosa, Borneo, and Singapore, and contain reference to many phenomena in Natural History, which are both new and remarkable, and which we trust Mr. Collingwood will take the trouble of investigating further. His account of the pill-making crab of Labuan, is a little sketch which recalls some of the descriptions in *Darwin's Journal.* The singular crustacean it relates to is in Mr. Spencer Bates' hands—and it could not be in better care —and has been named *Sphærapœia Collingwoodii*, or in simple English, the pill-making Collingwood.

THE OCEAN WORLD.*

HERE is another English reproduction of one of M. Figuier's popular scientific works, or rather, to be more correct, of a series of slicings from certain of his Natural History writings. Are we to give it unqualified praise, or to point out its defects? Or shall *medio tutissimus* be our motto, lest we be crushed beneath some touching parable, like that which the translator somewhat too literally renders in the Preface? "One of those charming children we sometimes meet with, lately said to M. Figuier, 'They tell me thou art a *vulgariser* of Science. What is that?'" Now, without commenting on the acuteness of children of this kind, let us see how delightfully dramatic was M. Figuier's reply: "He took the child in his arms and carried it to the window, where there was a beautiful rose-tree in blossom, and invited it to pull a rose." The child gathered the rose, but not without receiving a few of the thorns. "Thou art now a vulgariser," said M. Figuier, "for thou takest to thyself the thorns and givest the flowers to others." This pathetic little incident is given as a hint to severe critics, and of course we, among the number, have profited by it, though we must confess that we fail to see the exact analogy to which it points. However, let us now see the character of the rose which M. Figuier has plucked for us in the book upon our table. He attempts the description of all marine invertebrates, and of the cartilaginous and bony fishes, and he gives us a very handsome volume,

* "The Ocean World," translated from *La vie et des mœurs des Animaux.* Par Louis Figuier, illustrated by 427 Engravings. London: Chapman and Hall, 1868.

amply and prettily illustrated. Beyond this we cannot say much in its favour, and really this time we think we must lay the blame on the translator rather than on M. Figuier. If the French populariser falls occasionally into error, it is the duty of the translator to correct him, especially when the author is merely a dilettante, and the editor offers the work as an accurate exposition of science. The chapter on the coral, for example, is taken wholesale, illustrations and all, from Lacaze-Duthier's splendid memoir, but assuredly the French Naturalist has not spoken of the creations described by him as *Corallines*. But this is not all: to make confusion worse confounded, the editor, after very imperfectly rendering Lacaze-Duthier's account of the formation of the polypidom (polypier he calls it), proceeds to write of the Bryozoa as though they were coral-polyps, and makes the following remarks, which speak for themselves: "Our information fails to convey any precise notion of the time necessary for the coral to acquire the various proportions in which it presents itself. Darwin, who examined some of these corallines very minutely, tells us that 'several genera (*Flustra*, *Eschara*, *Cellaria*, *Cresia*, and others) agree in having singular movable organs attached to their cells; the organs in the greater number of cases very closely resemble the head of a vulture, but the lower mandible can be opened much wider than a real bird's beak,'" &c. Then follows an account of "coral-fishing." Now, anything more blundering than this we have never seen in any class of popular science works. It is laughable from its very absurdity. Why, it would be as ridiculous to group monkeys with frogs, as to place side by side the coral polyp and the Bryozoa. And then to make Mr. Darwin appear responsible for the affinities, by quoting him in the wrong place. Really M. Figuier is quite inaccurate enough on his own account, but his English translator out-Figuier's Figuier with a vengeance. We have not patience to go at further length into a notice of this work.

STAR-FINDING.*

PERHAPS the greatest difficulty which first presents itself to the amateur star-gazer is the task of finding out what to look for, what objects toward which to direct his assisted vision. The second difficulty is nearly as great; it relates to the method of looking at those heavenly bodies which he can first study to the greatest advantage. These stumbling-blocks are readily removed when the young astronomer has the assistance of "an old hand" to guide him; but we fear that to those who have not the benefit of what is known in universities as the "Tutorial method," the obstacles more frequently vanquish the student than the student the obstacles. We believe that this is one of the gravest reasons for the fact that so exceedingly fertile a field as that of astronomy is left comparatively unworked. But with the help of books like that which is now before us, and Mr. Proctor's "Half-hours with the Telescope," these barriers to the general study of as-

* "Celestial Objects for Common Telescopes." By the Rev. T. Webb, M.A., F.R.A.S. 2nd edition. London: Longmans. 1868.

tronomy will soon be removed. And we can be all the more hopeful of the good fruit to be yet borne when we reflect what the condition of amateur natural science was some sixteen or twenty years ago, when the microscope itself was as great a curiosity as some of the creatures which have since been revealed by it. We do not think that it is too much to expect that the future progress of popular astronomy shall be in the same ratio. Mr. Webb's book appears to be a well-arranged one, and to contain reference to most of the recent advances in astronomical science. It might, we think, have been more amply illustrated; but we should remember that illustration is not always compatible with cheapness, and that the author's object has been to lay before all who care for his subject a book which it is within the means of all to purchase. He divides his work into three parts: 1st, he deals with the telescope and the observer; 2nd, he gives an account of the solar system; and 3rd, he describes the so-called fixed stars. The portions of the treatise which appear to us to have really the highest value to the young student are those which relate to testing the telescope, so as to detect any faults, and to the best mode of using the instrument in making observations. On these points the author is very explicit. The hints to those who are about to buy a telescope are so valuable that we do not hesitate to quote them, at least in part. "In buying a telescope," says Mr. Webb, "we must disregard appearances. Inferior articles may be showily got up, and the outside must go for nothing. Nor is the character of the glass or the polish of the mirror any sign of excellence; these may exist with bad figure (*i.e.* irregular curvature), or bad combination of curves, and the inevitable consequence, bad performance. Never mind bubbles, sand-holes, scratches in object-glass or speculum; they merely obstruct a very little light. Actual performance is the only adequate test. The image should be neat and well defined with the highest power, and should come in and out of focus sharply; that is, become indistinct by a very slight motion on either side of it. A proper test-object must be chosen. The moon is too easy; Venus too severe, except for first-rate glasses; large stars have too much glare; Jupiter or Saturn are far better; a close double star is best of all for an experienced eye; but for general purposes, a moderate-sized star will suffice. Its image in focus with the highest power should be a very small disc, almost a point, accurately round, without 'wings,' or rays, or mistiness, or false images, or appendages, except one or two narrow rings of light, regularly circular, and concentric with the image, and in an uniformly dark field; a slight displacement either way should enlarge the disc into a luminous circle. If this circle is irregular in outline, or much brighter or fainter towards the centre, or much better defined on one side of the focus than the other, the telescope may be serviceable, but it is not of any great excellence. The chances are, however, against any given night being fine enough for such a purpose, and a fair judgment may be made by day from the figures on a watch-face, or a minute white circle on a black ground placed as far off as is convenient." We have given thus much of Mr. Webb's excellent advice, as a sample of the character of his book, but we have by no means included all his remarks, since the observations we have quoted refer especially to the common achromatic telescope. The author's guidance of the observer is as clear as it is indispensable to the beginner. Indeed, we have no hesitation

in saying that Mr. Webb's book is one which will develop many young astronomers, who by careful attention to its pages may immortalise themselves by discoveries in a department of science which is as fascinating to the ordinarily thoughtful man as it is sublime to the philosopher. There is but one thing wanting to complete the book, and we wonder it did not suggest itself to an author who has clearly striven to prepare a Royal Road to a difficult science. It is hard to explain it in a few words, but we shall try. Why did not Mr. Webb select some particular night in the year, provide the student with a map—like those excellent compilations of Mr. Proctor's—tell him how to place his telescope, and how to examine the objects there visible? Something of this kind would, in our opinion, have been invaluable to the tyro; it would, as it were, have put him "on the track," as the Americans say, and his course would then have been simply a progressive one.

SKETCHES FROM BEETLE-LIFE.*

THIS is a little book upon the natural history of land-beetles, and addressed, if we may judge from the style, to young children. The inaccuracies are as few as is usual in these cases, and the style is pleasant, but in parts partakes a little too much of the condescendingly funny. There are some who think that this mode of putting facts is the best adapted to the juvenile and uneducated mind. We have our doubts about it; and though our opinions once tended to favour these views, a riper experience has very materially modified them. It is argued that knowledge of facts alone is too dry and indigestible a pabulum for the young, and that, to make it palatable, it must, like the terrible "powders" of our childhood, be covered with some toothsome jam. This idea involves the supposition that the subject cannot be made interesting in itself. If so, then all we can say is, let it alone. If natural history does not embrace sufficient romance to interest the imagination of the young, there can clearly be little use in administering it like the powder we have referred to. We are not favourable to books such as those of Mona Bickerstaffe's, because we think they do not expand the mind, but rather, as a clever man has recently said, they fill it like a badly-packed portmanteau, whose proprietor is utterly incapable of laying his hand on what he wants without absolutely emptying it of its contents. This, of course, is only *our* opinion, and doubtless there are many who hold quite a different faith; to them, the book before us will be extremely "entertaining and instructive."

* "The Sunbeam's Story; or, Sketches from Beetle-life." By Mona B. Bickerstaffe. Edinburgh: Johnstone & Hunter. 1868.

THOUGHTS OF A PHYSICIAN.*

A PHYSICIAN has in this little volume expanded, or rather added to, the essays which he some time ago published under the title of "Evening Thoughts." How are we to describe the character of his reflections? As deeply philosophical? No, they are not that; they are the expression of thought, associated with a tolerable experience of "men and things," a patient disposition, a kindly tendency to look on the bright side of human nature, and a Christian feeling towards his fellows. "A Physician" is never deep in his descent into the analysis either of mind or of social laws, and yet he is impressive. He savours of wisdom, and indeed he is wise, but it is that wisdom which we find in the old, who have felt the cares of life, and have gone through the weary journey of existence buoyed by a belief in a glorious hereafter. Many of his generalisations could be cut to pieces by a sceptic of even ordinary penetration, for they are logical only so far as they are based upon premisses whose claims are inadmissible. He is the Christian of precept, not the denunciating firebrand of the schools. He is the Christian gentleman of the old times, when, as Mr. Reade somewhat satirically observes, "even Christians loved one another." Hence, through his gentle kindliness of tone, and his sound practical advice, we listen to him with respect, though we by no means assent to all his conclusions. However, we can commend his collection of essays to all our readers, as something out of the common herd of "good books"—that dreadful category of all that embraces intolerant doctrine, narrowness of thought, and bad English. "A Physician's" thoughts on the "Inheritance of Diseases," "Some Relations of the Will to the Brain," and on "Words without Thoughts," have much in them of force, truth, and earnestness.

MAN'S ORIGIN AND DESTINY.†

TO talk of putting a girdle round the earth in forty minutes is as nothing compared with the task which the author of this work has set himself, and has assuredly not performed. Just think of the subject—"Man's Origin," to say nothing at all of the *in nubibus* proposition as to his Destiny as a race. There is something trans-Atlantic in the audacity of the effort to embrace within the scope of a small octavo volume a series of problems, which may perhaps be solved in some future century, but which we are certainly not prepared to enter upon in this year of grace. It indeed reminds us of the Yankee's geographical description of America—that it was "bounded on the east by the rising sun, and on the west by the day of judgment." Mr. Lesley's subject is limited in a somewhat similar fashion, and yet he confidently sets about reducing the whole of it to a few simple sketches, extending over less than 400 pages. Of his aim we can form little

* "Thoughts of a Physician." London: Van Voorst. 1868.

† "Man's Origin and Destiny, sketched from the Platform of the Sciences." By J. P. Lesley. London: Trübner. 1868.

idea, but of the way he has set to work we have evidence enough, and the result is not at all satisfactory. The author resembles an indiscreet cook, who has so filled her pudding with raisins that it is simply nauseating. Mr. Lesley has been so anxious to accumulate the bricks and mortar of the structure he has attempted to raise, that he has had no time to exercise the architect's skill in putting them properly together. Abandoning metaphor, we may say of his book, that it is so overloaded with facts, that it looks more like a combination of Brewer's "Guide to Science" and Mangnall's "Questions," than a rational scientific treatise, in which facts are simply brought in to illustrate theories or support generalisations. Of cuttings we have a multitude, but they only perplex the reader; for no sooner has the author given a quotation than he flies away from it at a tangent, and gives us his own general opinions upon the matter—these being, we must add, quite irrespective of the facts—a sort of "independent opposition" which must have been highly gratifying to Mr. Lesley, but which he has no reason to be proud of. The author appears to have had for his chief object the exhibition of his own knowledge; and in this he has been very successful, so far as, say, half-a-dozen standard text-books can give a man erudition. Beyond this, we have nothing but flippant commentary, shallowest of the shallow. The following list of the branches of science mutilated gives a notion of Mr. Lesley's comprehensive mind:—The classification of the sciences; the genius of the physical sciences, ancient and modern; the geological antiquity of man; on the dignity of mankind; on the unity of mankind; on the early social life of man; language as a test of race; the origin of architecture; the growth of the alphabet; the four types of religious worship; on Arkite symbolism; appendix. To the educated, this book is about the most uninteresting general essay ever published. To the ignorant, it will gratify the author by recalling the old lines—

> "And still they gazed,
> And still the wonder grew,
> How one small head could carry all he knew."

ELEMENTARY MINERALOGY.*

WEALE'S series—of which this book is the expansion of an old edition—are excellent manuals for the working student. Of this fact we can offer no better illustration than the various volumes included in the series known to our readers. We think, however, that in some respects the work which Mr. Ramsay has endeavoured to bring up to the present stage of scientific knowledge is hardly a representative one. We by no means wish it to be understood that the book is not a very good mineralogical manual, but we do not hesitate to say that it might have been considerably improved. Mr. Ramsay has certainly made "an effort" to give a scientific

* "The Rudiments of Mineralogy, a concise view of the General Properties of Minerals." By Alexander Ramsay, jun. London: Virtue & Co. 1866.

polish to his work, but we fear that he has done so in immaterial points, to the exclusion of matters of high general interest and great practical importance. It is very well, and no doubt creditable to Mr. Ramsay's progressive tendencies, that he should construct his formulæ upon the most approved system. Equally well does it reflect upon his knowledge of modern language that he should have referred to Rammelsberg's and Des Cloizeaux's treatises. But, while achieving these excellent ends, why did he not cast his eye over the work done nearer home? Why, for instance, did he not give us some rough idea of how Sorby has used the spectroscope in the examination of minerals? and, above all, why did he not even hint at the fine and fertile field of inquiry which the employment of the microscope has recently opened up in the hands of that accomplished mineralogist, our countryman Mr. David Forbes? We should like to know also why Mr. Maskelyne's system of classification has been so religiously adopted. Mr. Maskelyne is a *savant* of much celebrity, but he is by no means infallible, and it is possible, even with the "dim lights" which illumine science in these days, to conceive of an arrangement of minerals, which shall accord more with natural affinities than that of the British Museum. The illustrations, too, strike us as imperfect in artistic execution, and infinitely too small in number to be of any practical value to the student. Again, why is Dr. Wollaston's Gonometer the only one described, and why are such minerals as Polytelite* and Titanoferrite omitted? We have also to find fault with the list of localities. For instance, on turning to Andalusite, we find the following statement as to its distribution:—"The Forez mountains of France, near Nantes and Morlaix in Bretagne; at Lisens in the Tyrol; at Wundsiedel in Bavaria; at Braunsdorf and Munzig in Saxony; at Almeria in Andalusia; and various places in Brazil." This is all. Mr. Ramsay would send us to Brazil for a specimen of Andalusite, and yet we promise him that in a day's excursion to Carrig-Holahan in County Wicklow (where we were first shown it by the late Dr. Kinahan), we could procure him specimens by the hundred. Poor Andalusite—"thou art so near and yet so far," if we would believe Mr. Ramsay. Now we have done. We have found all the fault we could, and in conclusion, we can only say that, notwithstanding these few omissions, Mr. Ramsay's is both a useful and handy little book.

SIR JOHN RICHARDSON.†

APART from the fact that the late Sir John Richardson was a man whose scientific reputation and fame as an Artic explorer entitles his name to a foremost place in our memoirs, there is something extremely touching in the statement of his biographer, that in a correspondence extending over

* We thought we should perhaps find this mineral noticed under the head of Tetrahedrite, but we found no mention of its occurrence in Great Britain.

† "Life of Sir John Richardson." By the Rev. John McIlraith. London: Longmans, 1868.

sixty years, there does not occur an unkind sentence regarding a human being. The subject of this memoir was born in the year 1787, and died suddenly, but calmly, on June 5, 1865, thus completing a tolerably long life. Few men have had a wider experience as travellers, or have shown so much energy and enterprise in following the path chosen by them. Beginning life as a surgeon to the Dumfries Infirmary, he soon tired of the routine of hospital practice, and entered the navy as assistant surgeon to the *Nymph* frigate, having passed an examination, which he naïvely states "took only fifteen minutes, and was quite easy." In 1808-9 we find him, after some service in the Danish war, promoted to be acting surgeon of the *Hercules* and subsequently surgeon to the *Blossom*, sloop of war. This correspondence shows him as leading an active life, and as present in many of the great engagements of the troubled times in which he lived. His first post of scientific importance was that which he obtained in 1819. He was the appointed surgeon and naturalist to the expedition being then fitted out to explore the Arctic Sea, and he became one of the officers appointed to accompany Franklin. This was really the commencement of Richardson's scientific career. Before joining the expedition he devoted himself to the study of the natural sciences, and in this way formed the acquaintance of Sir Joseph Banks, Dr. Leach, Dr. J. E. Gray, and many other illustrious *savants*. Of the horrible sufferings of the first Franklin expedition, every one knows something. But those who would have the miseries undergone by those poor fellows vividly put before them, should read Richardson's letters in McIlraith's biography. In 1823 the expedition, which had endured so many privations and sufferings, arrived in London. The pleasant little volume which Mr. McIlraith has written describes the further incidents of Richardson's life in terse and vigorous language, and since Richardson was so much associated with that great and good man Franklin, we urge upon our readers to take the book up and consult its pages for themselves. Sir John Richardson deserves better to be known as an intrepid explorer than as a discriminating naturalist; but it must not on that account be thought that his contributions to Zoology, which are both numerous and various, are unimportant. Not the least interesting item in the "History of Sir John Richardson," is the fact, that he was instrumental in introducing to the scientific world a naturalist who has, we may say, completely remodelled the whole scheme of Biology. We refer to Professor Huxley, who, under the advice of Sir John Richardson, was appointed assistant surgeon to the surveying expedition to the Eastern coast of Australia. It was in this voyage that Professor Huxley collected the materials of his finest monograph, that on the "Oceanic Hydrozoa," one of the memoirs of the Ray Society.

A Key to the Exercises in Galloway's First Steps in Chemistry. London: Churchill, 1868. This little volume will be found very useful by those self-teaching students who possess the original work. It contains th answers to and explanations of the Exercises which Mr. Galloway sets the student in his "First Steps."

The Transactions of the Royal Society of Victoria, 1868, have been forwarded to us by the Secretary. They form a thick octavo volume, and con-

tain some papers of excellence; notably one, a memoir of 130 pages on Australian *Coleoptera*, by Count F. de Castelnau.

Bible Animals. By the Rev. J. G. Wood. Longmans. The published numbers of this work have all reached us. The book shall be noticed when completed.

Vis Inertiæ. By W. L. Jordan. Longmans; and *Education and Training.* By A Physician. Churchill. Reached us too late for notice in this number.

The London Student. Churchill. We have received the first three numbers of this Journal.

SCIENTIFIC SUMMARY.

ASTRONOMY.

Motion of Sirius in Space.—Mr. Huggins has led the way in a process of inquiry which promises results of the utmost value and interest. It will be remembered by many of our readers that M. Doppler suggested, several years ago, the possibility that the colours of the fixed stars, and more particularly the colours of the double stars, may be partly due to motions of recess or approach which these stars may have with respect to the earth. He pointed out that the waves of light proceeding from a star would be apparently shortened if the star were approaching the earth very rapidly, and *vice versâ*. In other words, the spectrum of a star would be shifted from the red towards the blue end of the spectrum in the case of a star rapidly approaching the earth, and from the blue towards the red end of the spectrum in the case of a star rapidly receding from the earth. But Doppler failed to notice that no effect could be produced upon the colour of a star by changes of this sort. For at either end of the visible spectrum there exists an invisible prolongation, due to waves longer or shorter than those which the eye is able to appreciate as light. Hence the rapid motion of a star, either towards or from the earth, would in reality produce no effect on the several appearances of the spectrum, since one or other end of the visible spectrum would become invisible, while a corresponding portion of the invisible part beyond the other end of the spectrum would be rendered visible, the apparent colours remaining unchanged. And further, the rate of motion required to produce a change of colour, even in the imaginary case of a monochromatic star, would be far greater than we are justified (on any evidence we have) in assigning to the fixed stars. A velocity of 100 miles per second may be looked upon as absolute rest, in comparison with the enormous velocity of light; and a velocity ten times as great would probably be required to produce any appreciable change of colour in monochromatic light.

But Mr. Huggins has applied M. Doppler's principle in a far more satisfactory manner. The presence of dark lines in the spectra of the fixed stars, and of bright lines in several of the nebulæ, and the known fact that these lines correspond to those of certain terrestrial elements, suggested the possibility of ascertaining whether any minute variation in the position of certain well-known lines might not be found to give evidence of stellar or nebular motions of recess or approach.

After a long process of experiment and observation, Mr. Huggins has

succeeded in solving the difficult problem we have indicated above. He has made use of a spectroscope having a dispersive power seven times as great as that of a single equiangular prism of crown glass. This powerful instrument failed to indicate any signs of motion in the great Orion nebula and some others of the gaseous nebulæ which Mr. Huggins examined by its means. But he was more successful with the bright star Sirius. Having satisfied himself that a well-marked line in the spectrum of this star really corresponds with the bright line F of hydrogen, he brought the spectra of Sirius and of incandescent hydrogen into direct comparison. He found that the line F of Sirius was separated by about the 250th part of an inch from the corresponding line in the spectrum of hydrogen. The displacement was towards the red end of the spectrum, indicating a motion of *recession* between Sirius and the earth. When this motion has been reduced by the amount of motion which the earth had from Sirius at the time of observation, it results that Sirius has a motion of recession from the sun at the rate of no less than 930 millions of miles per year. Still further reducing this result, on account of the sun's estimated motion towards the constellation Hercules, we obtain a *proper motion of recession* of about 780 millions of miles per annum. The star's *observed proper motion*, which amounts to about 1¼ seconds annually, when combined with the best estimates of the star's distance, indicates a *proper transverse motion* at the rate of 450 millions of miles per annum. Hence *the actual motion of the star in sidereal space is readily shown to be about nine hundred millions of miles per annum.*

There is nothing to prevent this mode of inquiry from being applied in time to all the more conspicuous stars, or even to all the lucid stars, so that, instead of the vague notions we have been hitherto able to derive from the stars' apparent proper motions, which only enable us to determine roughly their real transverse motions, we shall be enabled to judge of the amount and direction of their actual motions through sidereal space.

Brorsen's Comet.—The re-discovery of Brorsen's comet has been hailed with more interest than would otherwise have been due to it, on account of the fact that Biela's comet was not seen on the occasion of its last return; so that a certain amount of dubiety had begun to be attached to the returns of the members of that family of periodic comets to which Biela's and Brorsen's belong. Brorsen's comet will now be visible for several months, as it will traverse the northern constellations Ursa Major and Boötes, drawing gradually nearer to the earth until August, after which it will recede from the earth. Mr. Huggins has examined this comet with the spectroscope. The spectrum consists of three bright bands, on a background formed by a very faint continuous spectrum. In one of the bands two bright lines appear. From the breadth of the bands at right angles to the length of the spectrum, it is evident that their light comes from the coma as well as from the nucleus. On the other hand, the two bright lines appear to belong to the nucleus alone. The conclusion to be drawn from these observations would appear to be, that the comet shines, for the most part, by its own light, the outer parts only of the coma shining by reflected light. In this respect the comet differs from the two which Mr. Huggins had before analysed, whose comæ, it will be remembered, shone by reflected light, the nucleus alone being self-luminous. The nucleus of Brorsen's comet appears also to contain

elements which do not appear in the coma, and which give rise to the two bright lines mentioned above.

Spectra of stars of seventh magnitude.—The Padre Secchi has examined a large number of red stars with the spectroscope. Many of the stars thus examined are below the seventh magnitude, so that it would appear as if, with suitable instruments and in favourable atmospheric circumstances, the process of research commenced by Mr. Huggins might be applied to many telescopic stars.

The Nebula of η Argûs.—A paper has been communicated to the Astronomical Society by Mr. Abbott, in which it is alleged that the remarkable nebula around η Argûs has varied considerably in figure during the past few years. Sir John Herschel, however, is not disposed to consider Mr. Abbott's reasoning conclusive. The very great difference in magnifying and light-gathering power between a 5-feet achromatic and the great reflector made use of by Sir John Herschel, seems quite sufficient to account for the difference between the views of the nebula which accompany Mr. Abbott's paper and the noble drawing in Herschel's "Cape Observations."

While on the subject of this great irregular nebula, we may mention, that Lieut. Herschel has analysed it with the spectroscope supplied by the Royal Society to the Eclipse expedition, of which he is the head. The spectrum of the nebula consists of three bright lines, so that this nebula—like the great Orion nebula—is gaseous.

We hear of five expeditions sent out to view the great Eclipse. First there are the two sent out by the Royal Society and the Royal Astronomical Society. Prussia sends out an expedition to Aden; M. Jansen heads one sent out by the French Government; and the Pope sends out Father Secchi. Mr. Posson, of the Madras Observatory, will also take part in observing the great Eclipse.

A Globe of Mars.—At a late meeting of the Astronomical Society, Mr. Browning exhibited a globe of Mars, on which the lands and seas of this interesting planet were marked in, and named as in Proctor's chart of Mars. With the exception of Phillips' globe of Mars, this is, we believe, the first attempt to illustrate the varying appearance of Mars by means of a Martial globe.

Venus and Saturn.—Venus has been very favourably situated for observation during the past few months, and many observers have detected markings on this beautiful planet. Mercury has also been observed under favourable circumstances during several weeks of June.

Saturn, though low, has been an interesting object of observation. His rings are now well open. We do not hear of any discoveries worth recording. Indeed, it is unlikely that any observations made when the planet is in the wintry half of the zodiac should reveal peculiarities undetected when the ring was last seen at its full opening—in the oppositions of 1855–1857, during which it rose more than 40° higher above the horizon than at present.

Changes in Planetary Nebulæ.—Mr. Key has observed changes in the planetary nebula 45 II. iv. Geminorum, which seem very remarkable. New rings appear to have formed around the stellar nucleus of this nebula. Mr. Huggins states that the nucleus gives a stellar spectrum; but he is uncer-

tain about the spectrum of the luminous haze, as the night on which he observed the nebula was an unfavourable one. He thinks, however, that the spectrum of this part of the nebula is also continuous.

The 98th asteroid has been discovered, so that we may soon expect to enter on the second hundred. Considering that the first of these new planets was discovered on the opening day of the century, we may consider that satisfactory progress has been made in the search for these objects.

A clock movement is being prepared for the great Parsonstown reflector. When this work is complete it is intended that the enormous light-gathering powers of this noble instrument should be applied to experiments in lunar photography and stellar spectrometry. For the last-mentioned purpose, a fine spectroscope is now in course of construction by Mr. Browning.

The results of the examination to which the great Orion nebula was subjected by the late Lord Rosse, have been published in the *Philosophical Transactions of the Royal Society*, and are illustrated by a large and valuable map of the nebula. The long series of observations of the same nebula which were made by the late G. P. Bond, and his careful measures of the stars scattered through the nebula, have been edited by Professor Safford, and form the fifth volume of the "Annals of the Observatory of Harvard College."

BOTANY.

Cœlebogyne ilicifolia.—M. Baillon has transmitted a note on this remarkable plant to the French Academy of Sciences. The plant was introduced into England, from Australia, about 40 years since. By a peculiarity, long unexplained, all the flowers produced by it in the Botanic Gardens were female, and yet they bore perfectly normal seeds. Hence it was concluded that the *Cœlebogyne* was a perfect example of a parthenogenetic plant, *i.e.* of a plant producing seeds without any previous fertilisation. But, as in other species of diœcious plants, supposed to be parthenogenetic, stamens have been sometimes found when only female organs were expected, botanists were led to ask, might not stamens also be found in *Cœlebogyne.* Indeed, Herr Karsten was lead by his researches to affirm, that there may be seen a small stamen beside the pistil of the female flower, bearing pollen in very good condition. According to the German botanist, this occasional hermaphroditism would account for production of the healthy seeds. M. Baillon adds a new fact, to show that this plant is not diœcious. He placed before the Academy, at its meeting on May 6, two specimens of *Cœlebogyne*, which had been sent from Australia by Dr. Ferdinand Müller, and in both of which might be seen, on different branches, numerous male and female flowers, many of them passing into fruit. Thus the plant must in future be considered monœcious, and not diœcious, as hitherto supposed.—*Comptes Rendus*, May 6.

The Microscopical examination of Diatoms.—A paper read before the Société Philomathique, of Paris, on April 18, on the above subject, contains one or two points of interest to our readers. The author, M. Fréminau, makes the following remarks:—"The ordinary method of examining the

Diatomaceæ consists in illuminating the object by means of oblique light, so arranged that the reflected bundle strikes it at an angle of 45°. This method he considers most unsatisfactory. Here then are three other ways of illuminating, say *Navicula*. The *first* consists in passing solar light directly through the object, and protecting the retina by a blackened glass placed over the objective. This mode, he says, gives the striæ very well. The *second* consists in employing the solar spectrum, reflecting from the mirror the light between orange-yellow and greenish-yellow. The *third* consists, whatever may be the magnification, in illuminating the *Navicula* directly, as opaque objects are illuminated, but by a somewhat different process: we place, says the author, an equilateral prism on the level of the stage, and then we direct a bundle of rays—either white or spectral—between the preparation and the object, and we see the striæ black upon a coloured ground. These processes do not require great experience for their satisfactory employment, but may readily be adopted by the amateur. These methods, says the author, have given me valuable assistance in the examination of *Diatomaceæ*, and they are equally applicable to other substances. He suggests the following substitute for solar light:—A hemispherical condenser is placed in front of a conical reflector, and a lamp is set between the two. This lamp should be a magnesium lamp, or a lamp in the centre of whose flame a cylinder of solid magnesia has been placed.

The genus Cochliostema forms the subject of an interesting paper, recently published by Dr. Maxwell Masters in the *Gardener's Chronicle* (pp. 264, 323). It would be impossible, in the brief space at our disposal, to do more than refer to Dr. Masters' memoir, the anatomical details being too numerous and complex to enumerate them shortly and without figures. We may remark, however, that the author demonstrates very clearly, that there is more to be seen, on minute examination, than M. Lemaire's description would lead one to suppose.

The Natural History of Blights.—A number of questions recently put by Dr. Gavin Milroy, an active member of the Epidemiological Society, have been replied to by the Rev. M. J. Berkeley. The answers are of the utmost importance, both to the botanist and the student of hygiene and epidemics, and are published in recent numbers of the *Gardener's Chronicle*. In reference to the theory of Hallier, viz. that cholera is produced by a species of fungus growing on diseased rice, the Rev. J. M. Berkeley remarks:—"I do not believe in Hallier's views of the connection of cholera with parasites on rice. I am taking great pains to ascertain what are the rice parasites. I believe Hallier's notions to be entirely theoretical. That some cutaneous disorders arise from fungi is pretty evident, but there is nothing to show that fever, or other infectious or contagious diseases, arise from the same cause. It was supposed that diphtheria depended on a fungus, but I have examined diphtheritic membranes in which there was no fungus." In reference to the mode of entrance of the parasitic fungus, Mr. Berkeley writes:—"In the bunt the whole process is traceable; the parasite obtains admission from without, and the spawn traverses the young plant. In plants impregnated by myself I have seen the stem as well as the grain affected; but I never saw this in the fields. The potato murrain, again, is distinctl traceable in affected tubers, the threads seeming to have a power

of decomposing the cell walls, so as to gain admission to the tissues very deeply. In some cases the effect of the presence of the parasite is to produce a hypertrophy of the tissues, in bunt an intensity in the colour of the chlorophyll, or at least such an alteration of colour, that a practised eye will at once detect a bunted plant. In many cases, however, I doubt whether the best microscopes will always detect fungus spawn, and such investigations require great caution, as the junctures of the cell walls are very deceptive."

Fungi in Flint.—At a meeting of the Chemical Society (April 2), Mr. W. Chandler Roberts read a paper, in which he described some singular organic appearances which presented themselves in colloid silica, obtained by dialysis. He found this silica, on drying, to present a series of dendritic objects, which have all the characteristics of fungi. Mr. Roberts supposed them to be mimetic phenomena on the part of the silica. We have since, however, learned from Mr. H. J. Slack, who has been working at the subject, that these dendritic forms are nothing more than fungoid growths which have become imbedded in the silica, whilst in its liquid condition. Singularly enough the hardening and contraction of the silica does not appear to injure the soft structure of the fungoid arborescence. Is this because, previous to condensation, the silica had entered into the substance of the fungoid cells?

Why is Mould found in Carbonate of Soda?—M. Le Rique de Monchy has published a note in the *Comptes Rendus* of the French Academy, in which he states that, in all the unfiltered commercial bicarbonate of soda which he has examined, he has found multitudes of what are styled "molecular granulations." These he believes to be nothing more than fungus spores, and he adds, "they account for the production of vegetable matter in situations where one is surprised to meet with it."

The Morphology of the Pistil and Ovary.—The French Academy's commission has reported on the three essays sent in for the Bordin prize for 1867, and has awarded the prize to M. Van Tieghem for his labours. The author of the memoir considers that, before examining the distribution of the vascular bundles of the stem and ovary, it is necessary to understand exactly what is understood by the term axis, and what by the term appendicular. He then draws this distinction: when the vascular bundles are arranged in such a manner that in transverse section they form a complete circle, or, in other words, surround an ideal line, we have an illustration of an axis; when, on the other hand, the vascular bundles are co-ordinated in relation to a plane, we have an instance of an appendicular organ. Starting with these definitions, the author proceeds to a minute anatomical analysis of over fifty-five families of plants, selected to illustrate all the combinations of the organs whose morphology he desired to investigate. In order to avoid ambiguity, he has substituted for the term *axile placentation* the term *angular placentation*; since the former is associated with a hypothesis, while the latter is not. Some of M. Van Tieghem's conclusions will strike botanical readers as singular. For instance, he says that there are double appendicular organs which spring from the axis under the form of a simple bundle, and divide at a certain distance from the point of emergence into two simple superimposed appendices, and which may be said

to be inserted one upon the other. Again, he explains the adhesion of the ovary by assuming the original coalescence with all the floral whorls which are external to it; a coalescence of the same kind as that which unites the separate carpels into the compound pistil, or the petals and stamens into the monopetalous corolla. The Academy's commissioners do not quite concur in the opinions of M. Van Tieghem, but they think his conclusions worthy of all attention, and regard them as at least extremely ingenious. The memoir extends over 200 pages, and is illustrated by an atlas containing 500 carefully-drawn figures, illustrative of the plants examined, and of the dissections. The commissioners were MM. Brongniart Tulasne, Duchartre, and Trécul, and the reporter M. Decaisne. As showing how carefully the French conduct their awards of prizes, we may mention that the commissioners repeated several of M. Van Tieghem's dissections, and found his statements absolutely correct.—Vide *Comptes Rendus*, May 18.

Cellulose a Tissue.—Some very recent researches of M. Payen demonstrate the existence of cellulose as a distinct tissue, which, by careful chemical and physical operations, may be extracted from surrounding tissues of the plant, and examined under the microscope. The plant he first experimented on was the potato, the tubers of which he submitted to a process of freezing.—*Comptes Rendus*, tom. LXVI., No. 11.

The Vessels of the Musaceæ.—M. Trécul, with so many of whose researches on the vascular system of plants our readers are now familiar, has published a memoir on the above subject, in which he describes the situation and characters of the proper vessels in several genera of this family. He concludes that the *Musaceæ*, like the *Papaveraceæ*, present proper vessels of variable construction, but that the former have them in a less degree than the latter. M. Trécul's paper was presented to the French Academy on March 18.

New Botanical Works.—Among the many botanical treatises published of late, we may call attention to the following:—*Sur la Floraison de la Vigne*, by M. Henri Marès: Montpellier. *Les Conifères Indigènes et Exotiques*, by M. de Kérivan: Paris, 2 vols. with plates. *L'Art des Jardins*, by Baron Ernouf: Paris. *Botanique, Cryptogamique*, etc., par M. J. Payer, 2nd edition: Paris, 1868.

The Increase in Width of the Stems of Dicotyledons.—M. G. Colin has been following up the well-known researches of Duhamel, but he has been adopting a method of his own. Instead of inserting metallic plates under the bark, he has placed them in the thickness of the liber, and in this way he has experimented on the mulberry, the oak, the sycamore, and various members of the family *Rosaceæ*. He laid down the following questions for reply:—(1.) Are the new woody layers of *Dicotyledons* formed from the exterior of the older, and from the transformation of some of the elements of the liber, or are they the result of the formation of new elements in the developing (cambium) layer? (2.) In what order and manner is the development of the new layers accomplished? In regard to the first point he makes the following important remarks:—Experiment proves that the woody layer proceeds neither from the extension of the subjacent sap (?) nor from any modification of the elements of the liber, although, in the absence of the generative zone, the liber on the one hand, and the sap on the

other, may give rise to woody deposits of considerable thickness. If in the spring one introduces a plate of gold or platinum between the bark and the sap (? cambium), one finds in the autumn that a complete woody layer is formed external to the plate, and quite apart from the cambium. But the plate has not changed its position, and its inner face is exactly in the position where the old wood lay at the commencement of the experiment. From this the author concludes that the new woody formation was in no way due to any anterior formation.—See *Comptes Rendus*, March 30.

Development of Bacteria.—M. Béchamp, in a note, which was read to the Académie des Sciences on May 4, entered into a long account of the developmental relations of *Bacteria* and *Mycrozymæ*. Indeed he considered the latter to be the first stage of the former. The *Mycrozymæ* are normally simply minute spherical bodies. In this state they exist normally in the human body. But when the tissues are exposed to the air they grow into chains and become *Bacteria*. MM. Béchamp and Estor seem to think it a proof of these *Bacterias* being normal constituents of the body, that they are found in the liver. But after all, what is to prevent any organic germs from reaching the inmost centre of the liver, through the mouth, stomach, and gall duct?

CHEMISTRY.

A new Aspirator, which may be found useful by some of our chemical readers, has been described by J. Landaner, in the *Chemical News* (March 20). The new instrument is based on the principle of the syphon. A capacious flask is hermetically closed by a cork provided with two holes. One of the latter receives the syphon, and the other a glass tube for connecting the apparatus, through which the passing of a current of air is desired. After having made the connections and filled the flask with water, the latter is made to run out of the flask by sucking the outer leg of the syphon, the end of which must, of course, be lower than the level of the water. The current of air is thus effected. The efflux of water is regulated by joining more or less width to the tubes between apparatus and aspirator. Two aspirators are connected with the apparatus, and used alternately, in order to enable a refilling of the flasks without interruption of the process. For this purpose an intermediate apparatus, consisting of a glass tube about two inches long, and one inch wide, is required, which is connected on one side with the apparatus intended for receiving the current of air, and on the other side with the two aspirators. The latter connection may be effected by india-rubber tubes, each provided with Mohr's pinch-cock. Such arrangement will enable the alternate working of the two aspirators. It is of course understood that all the connections must be effected hermetically. One of the advantages of this aspirator is, that it allows an easy determination of the quantity of air passed through by employing graduated

Absorption of Arsenic, Tungstic, and Arsenious Acid by Charcoal.—Mr. Skey writes to the *Chemical News* to say that charcoal absorbs all these sub-

stances under certain circumstances. If a few drops of a solution of a salt of arsenic, or arsenious acid, is put into a few ounces of dilute sulphuric acid, and the mixed solution agitated at intervals with recently ignited charcoal, for an hour or two, the clear liquid obtained by filtration does not manifest any reaction of arsenic when tested by Marsh's process. Lignite has not the same effect as charcoal, though absorbent of weak acids and bases generally, as Mr. Skey has before shown. Tungstic acid also from acid solutions is removed by charcoal applied in like manner, and is given up to a solution of caustic alkali.

An Aniline Marking-ink, said to be indelible, is now commonly prepared in France by mixing the two following solutions:—*a*, cupreous solution—8·52 grm. of crystallised chloride of copper, 10·65 grm. chlorate of soda, and 5·35 grm. of chloride of ammonium, are dissolved in 60 grm. of distilled water; *b*, aniline solution—20 grm. of hydrochlorate of aniline are dissolved in 30 grm. of distilled water, and 20 grm. of a solution of gum arabic (1 of gum to 2 of water) with 10 grm. of glycerine are added. By mixing in the cold four parts of the aniline solution with one part of the cupreous solution, a green liquid is obtained, which can be used immediately for tracing characters upon linen; the marks, however, alter after the lapse of a few days. It is necessary to keep the solutions separate until required for use. If the fluid does not flow easily from the pen, it may be diluted without fear of diminishing the intensity of the tint, which, at first green, gradually darkens and becomes black. Heat causes the change to take place instantaneously; a steam heat is sufficient, and is better for the fabric than a hot iron. Afterwards the linen is washed in warm soap and water. This ink resists acids and alkalies, and is remarkably permanent.

Organic appearances in Colloid Silica.—At the meeting of the Chemical Society on April 2, Mr. W. Chandler Roberts read an extremely interesting paper on this curious subject. The colloid silica was, of course, obtained by dialysis. The results arrived at were very remarkable, and were elucidated by a series of specimens, both of artificial and natural origin, the structures of which were demonstrated by the aid of a microscope and illustrative drawings. In experimenting upon somewhat large quantities of soluble silicic acid prepared in Graham's dialyser, a portion of the liquid product was evaporated slowly in air to compare with the forms of hydrous silica left by a more rapid operation conducted *in vacuo*. All the specimens of jelly dried in air exhibited dendritic forms, varying in size from 0·2 to 0·5 m.m.; these were at first supposed to afford indications of the passage of colloid into crystalloid silica, but when magnified 90 linear they appeared as radiating fibres, and upon being further magnified 700 times each fibre resolved itself into a collection of elongated beaded cells, with clusters of circular cells at intervals. Such a structure would indicate a vegetable growth, and the author concludes that the markings, which are similar to those seen in moss agates and Mocha stones, are due to the growth of fungi or mildew in the partially solidified jelly. The spores of organic life were probably derived from the air, since no evidence of similar structure was visible in the specimens of hydrous silica obtained in the desiccator. These last-named products were very like the opal from Zimapan, but contained 21·4 per cent. of water.

Preparation of pure Bromides for medical purposes.—In the *Arch. Pharm.* (clxxxi. 216), Herr Faust describes the following method for the preparation of pure bromides:—Bromic sulphide is first prepared by mixing together 2 parts of sulphur (flower) and 24 of bromine; this is added to calcic hydrate, suspended in water, when the following reaction takes place:

$$2\,S\,Br_6 + 8\,Ca\,O = 6\,Ca\,Br_2 + 2\,Ca\,S\,O_4$$

The filtrate is saturated with carbonic anhydride, concentrated, and mixed with twice its bulk of alcohol. After a few days the solution containing pure calcic bromide is filtered off from the calcic sulphate, and evaporated. From this salt any other bromide may be obtained by mutual decomposition.

A new body from Chloride of Silicium.—It is reported that MM. Friedel and Ladenburg have found, that on passing the chloride of silicium through an empty porcelain tube heated to a temperature near that at which this substance fuses, and then distilling, a new substance less volatile than the chloride is obtained. By repeating the operation a great number of times with the more volatile portions, a notable amount of a liquid boiling above 70° is obtained. This product submitted to fractional distillation is easily separated into chloride of silicium and a liquid boiling between 136° and 139°. Limpid and fuming in the air, this liquid bears great resemblance to chloride of silicium; it is likewise decomposed by water energetically. Analyses were made by introducing weighed bulbs, full of the liquid, into flasks containing a certain quantity of water; breaking the bulbs afterwards, almost the whole of the silica, when sufficient water was present, remained in solution. The acid liquid, saturated with ammonia, was evaporated on the water-bath; the residue, dissolved in water, and filtered gave on the one side silica mixed with the glass of the bulb, on the other a solution in which the chlorine was determined. The numbers obtained lead to the formula Si_2OCl_6, from which the new body is seen to be an oxychloride of silicium.

The Absorption of Vapours by Charcoal.—Mr. John Hunter, of Belfast, continues his enquiries on this subject. In the last paper sent to the Chemical Society, he states that he has demonstrated the degrees and condition of absorption of each of the following substances: Ethylamine, iodide of ethyl, acetate of methyl, oxalic ether, hydride of salicyl, salicylic acid, iodide of amyl, napthaline, camphor, nitro-benzol, bisulphide of carbon, alcohol, acetone, and methylic alcohol.

The Quality of the Present and Future Water of London.—In an able summary of the results of a scientific investigation of the present water, and the water proposed to be supplied to Londoners by the various schemes now before the public, Professor Frankland states these nine conclusions: 1. The present water supply of the metropolis is largely contaminated with sewage. Both analysis and statistics concur in the statement that each glass of Thames water taken from the river by the companies, contains one tea-spoonful of sewage. 2. Although this sewage is generally, to a great extent, oxidised before the delivery of the water in London, yet there is no guarantee whatsoever that all its noxious qualities are removed, because these noxious qualities are, in all probability, contained in the mechanically

suspended and least oxidisable portion of the sewage. 3. The river water supplied in London is often very imperfectly filtered; and thus even the visible suspended matters of sewage are not wholly excluded from the water supply. Only on one occasion during the whole year 1867, have I obtained a transparent sample of water from the Southwark Company's mains. The Grand Junction Company's water was turbid four times out of twelve; the Chelsea thrice; the West Middlesex, Lambeth, and East London each twice, out of the twelve occasions when the samples were drawn for analysis. The New River Company alone delivered perfectly filtered water during the whole year. 4. The quality of the water supplied to London is greatly inferior to that of any other town in the United Kingdom, whose supply I have examined. 5. The distribution of water in the metropolis still continues, with but slight exceptions, on the intermittent system, a system which has been abolished in almost every town of importance in the United Kingdom. 6. The water which it is proposed to supply either from the Welsh or the Cumberland districts is of excellent quality. It is equal or superior to that supplied to any town in Great Britain. 7. The water from each of the proposed districts is extremely soft, pleasant to drink, and of good aëration. 8. These waters have never been contaminated with sewage, and are therefore above all suspicion. 9. They can be distributed in the present system of supply pipes without any danger of lead contamination.

GEOLOGY AND PALÆONTOLOGY.

New Fossil Reptiles from South Africa.—The *Geological Magazine* for May contains a paper illustrated by two capital lithographs, upon two forms of lacertilian reptiles which have been exhumed from the British Museum by Professor Rupert Jones, and which are now described by Professor Huxley. Professor Huxley says, that the matrix is the same as that in which the dicynodonts are embedded, but in the case in point the skeletal remains are not those of dicynodont, but of a lacertilian allied to Telerpeton, and about seven or eight inches long. For detailed description we must refer our readers to the excellent plates which accompany the paper. Professor Huxley calls the fossil *Saurosternon Bainii*, in compliment to Mr. Bain, who brought the specimen over from Africa.

The Cause of Contortion and Faults is the subject of a short paper by Mr. J. M. Wilson, of Rugby School. Mr. Wilson thinks that the explanations of the phenomenon in books are extremely unsatisfactory, and he gives a mathematically worked-out hypothesis of his own. He considers that contortion and faults are readily explained when one recollects: (1) That depressions and elevations take place over large areas; (2) That the surface of the earth is curved; (3) That rocks are compressible by foldings; (4) That rocks are not extensible or elastic; and (5) That at great depths rocks are somewhat plastic through heat.—Vide *Geol. Mag.*, No. 47.

The Fossil Insects of North America.—Mr. Samuel Scudder, of the Boston Society of Natural History, is so well known to students of fossil insects,

that readers of this class will be pleased to learn that the *Geological Magazine* (April and May) contains a valuable contribution from him on the fossil insects of North America. He deals at length with the formations in which the insects are found, and the character of the nodules, etc., in which they are present, and criticises closely the labours of his various *confrères*. He concludes his memoir by assigning the eighty-seven species referred to in it to their respective geological positions. Six of these, he says, are from the Devonian formation; fifteen from the carboniferous; one from the trias; and sixty-five from the tertiaries. Ten are *Coleoptera*: viz., one from the trias and nine from the tertiaries; four are *Orthoptera*, all from the carboniferous; nine are *Neuroptera*, viz., six from the Devonian and three from the carboniferous. Five more, either *Orthoptera* or *Neuroptera*, are from the carboniferous. Three are *Hymenoptera*, forty-five are *Diptera*, six are *Hemiptera*, all from the tertiaries. Three are *Lepidoptera*, viz., one doubtful from the carboniferous and two from the tertiaries, one of which is also doubtful. Two are *Myriapoda*, both from the carboniferous, but one of doubtful character. No spiders have been found fossil in America. From this it appears that the *Diptera*, *Hemiptera*, *Hymenoptera*, and *Lepidoptera* (omitting the doubtful ones from Illinois) are restricted to the tertiaries; the *Coleoptera*, with one triassic exception, to the same; the *Orthoptera* and *Myriapoda* to the carboniferous; while the *Neuroptera* are found in both the Devonian and carboniferous formations.

The Bone Caves of Brazil, and their history.—The *Popular Science Review of Scandinavia* * contains a most interesting account of the Brazilian bone caves, by Professor Reinhart. The Professor's conclusions have been thus formulated by a contemporary:—"1. During the post-pliocene epoch, Brazil was inhabited by a very rich mammalian fauna, of which the recent one might almost be said to be a mere fraction or a crippled remnant, as many of its genera, even families and sub-orders, have vanished, and very few been added in more recent times. 2. During the whole post-pliocene epoch the Brazilian mammalian fauna had the same peculiar character which now distinguishes the South American fauna, compared with that of the Old World; the extinct genera belonging to groups and families that to this very day are peculiarly characteristic of South America. Only two of its genera, the one extinct (mastodon), the other still living (the horse), belong to families that in our epoch are limited to the Eastern hemisphere. 3. All the mammalian orders were not in the same degree richer in genera in former times than now. The *Bruta*, *Ungulata*, *Proboscidea*, and, lastly, the *Feræ*, have relatively suffered the greatest losses. Some orders, for instance the *Cheiroptera* and *Simiæ*, number perhaps even more genera now than formerly. 4. The post-pliocene mammalian fauna of South America differed much more from the modern one, and was especially more rich in peculiar genera, now extinct, than the corresponding fauna of the Old World. 5. The scantiness of great mammalia—one might say the dwarf-like stamp impressed upon the South American mammalian fauna of our days, when compared with that of the Eastern hemisphere, was much less observable,

* Tidschrift for populare Fremstillinger af Naturnidenskaben, udginet af C. Togh az C. Lütken, 1867.

or rather did not exist in the prehistoric fauna. The post-pliocene mastodonts, *macrauchenia*, and toxodonts of Brazil, its many gigantic armadillos and sloths, could well rival the elephants, rhinoceros, and hippopotami, which during the same period roamed the soil of Europe."

Influence of Combined Volcanic and Denuding Agencies in producing Scenery of Scotland.—At a meeting of the Geological Society of Glasgow, on April 2, a paper by Mr. Powrie, on the above subject, was read at the meeting, by Dr. Page. Mr. Powrie is opposed to the views both of Mr. A. Geikie, and of the Duke of Argyll, and has offered facts and arguments against both of his opponents.

Geologists, and their Labours.—The following valuable table, which has been drawn up by Mr. George W. Ormerod, shows, almost at a glance, how vast is the number of scientific men who have devoted themselves to geology of late years. In addition, it has considerable importance as a means of reference to published papers on geological questions. The latter have relation only to the *Quarterly Journal* and *Transactions of the Geological Society* of London:—

	Titles of Papers in Index. 1807 to 1855 (inclusive). 49 years	Titles of Papers in Supplement. 1856 to 1867 (inclusive). 12 years	Authors of Papers in Index. 1807 to 1855	Authors of Papers in Supplement. 1856 to 1867
Tertiary & Recent.	575	436	310	31 Old authors 273 New "
Secondary . . .	693	434	330	45 Old " 229 New "
Palæozoic . . .	658	397	273	47 Old " 184 New "
Metamorphic . .	190	112	104	13 Old " 54 New "
Volcanic	288	170	145	21 Old " 85 New "
Plutonic	180	110	101	12 Old " 63 New "
Topographical Geology . . Miscellaneous	232	109	179	6 Old 81 New
Mining, &c. .	216	144	144	13 Old 83 New
Palæontology General . .	23	16	13	1 Old 11 New
Fauna . .	493	353	162	29 Old 102 New
Flora . . .	80	50	39	8 Old 25 New

The Volcanic Eruption of Central America.—It was stated in certain journals that the eruption which M. Ramon de la Sagra described to the French Academy, on May 4, occurred at Nicaragua. This is a mistake. The volcano was that of Conchaqua. This volcano faces that of Cosiguina.

Each of these mountains occupies a point of the bay of Fonseca. The eruption began on February 23 last, at seven in the morning. It was preceded by several earthquake shocks, which began on the 11th, and were so frequent on the 16th that no less than 115 were counted. The eruption was still going on formidably when the courier started on March 21.—*L'Institut*, June 3.

The Stone Age.—At a recent meeting of the Royal Academy of Belgium, M. Ed. Dupont read a most interesting paper on this subject. He agrees with modern archæologists, in thinking that the Stone Age must be divided into two sections: (1) The age of clipped flints; and (2) the age of polished flints.

The Fossil Fishes of Carinthia.—Herr Kner has published, in the *Transactions of the Royal Academy of Vienna*, a supplement to his memoir on this subject. His later researches have added no new species to the list already published by him, but have resulted in the discovery of some very perfectly preserved specimens, and, among others, fair examples of *Semionotus striatus.* In addition to these Herr Kner has discovered a saurian cranium, the first example of this type of life found in the Seefeld locality. Although this cranium has been considerably altered by the pressure to which it has been submitted, Herr Kner has been able to conclude that it belonged to a species of crocodile with a prolonged snout, like that of the gavial. The characters of its teeth and eyes induce him to refer it to the genus *Teleosaurus*, and he considers it to be a species yet undescribed. Herr Sandbergen, of the University of Wurzburg, has found, among the fishes found by Herr Kner at Raibl, what he regards as a new species of *Ptycholepis*, and, from the character of its scales, he has given it the specific name *P. tenuisquammatus.*

The War-Paint of the Prehistoric Man.— In a memoir some time since presented to the Royal Academy of Belgium, M. Ed. Dupont states that he had found, among specimens of ologiste from the banks of the Lesse, some which exhibited markings similar to those described by MM. Christy and Lartet, as found in specimens of red hæmatite, from the caverns of Périgord. M. Dupont concludes that the Troglodytes of the caverns of the Lesse ground down those minerals to obtain a reddish powder, which seems to be a favourite colour among all savages, and which, mixed with grease, was probably employed to paint their bodies, as the American Indians do nowadays.

Man in the Miocene Period.—At the meeting of the French Academy, on April 20, a sealed memoir by MM. Garrigou and Filhol was opened and read. The matter refers to a statement which we have already published, viz., that the existence of bones split longitudinally, in certain of the miocene deposits, proves the existence of man in that age of the world.

A Volcanic Circle.—In a letter to M. Saint Claire Deville, M. Fouqué makes some observations which confirm the opinions of M. E. de Beaumont on the subject of volcanic areas. M. Fouqué says, relative to the earthquake shocks at Cephalonia and Methilin, that if we unite by an arc of a great circle the points of the island at which the shocks have been chiefly felt we obtain a curve which passes by Etna and Teneriffe, and this curve will be found to pass through the plane known as the eruptive plane of

Etna. By prolonging this plane to the East, we see it passes through the principal volcanic centres of the Mediterranean, and even those on the borders of the Caspian sea.—Vide *Comptes Rendus*, March 30.

The Fossil Water-hen of Mauritius.—M. Alphonse Milne Edwards, who sometime since described this fossil Fulica to the French Academy, says that the species (*F. Newtonii*) was of great size, that it is now extinct, and that it existed contemporaneously with the Dodo (?) Dubois, who visited the Mascarene Islands in 1669 to 1672, in describing the birds of Bourbon, speaks of "water-hens as large as domestic fowl, all black, with a white crest on the summit of the head." This description cannot apply to the existing *F. cristata*, which is much smaller than an ordinary fowl. The bones of *F. Newtonii* examined by M. Edwards enable him to state that the extinct bird must have been about the size of a common hen, and hence he concludes that this species was the one spoken of by Dubois in his writings.—*Comptes Rendus*, tom. LXVI., No. 13.

The Probable Date of the Glacial Period.—Under this title Mr. James Croll has contributed to the *Philosophical Magazine* (May) a paper of much interest to the speculative geologist. Mr. Croll has not concluded his remarks in this memoir, but promises to do so in another. Nevertheless, we have much pleasure in calling attention to a most important paper on one of the grandest problems that can engage the attention of the man of science. We may mention, that Mr. Croll looks upon denudation as the key to the solution of the question—How old is the earth? He thinks that accurate ideas of denudation can only be formed when enough evidence concerning the quantity of sediment carried away by our rivers is accumulated.

MECHANICAL SCIENCE.

Stresses in Braced Structures.—Mr. W. Airy has communicated to the Institute of Civil Engineers a paper on the experimental determination of the stresses in complex braced structures, and particularly in bowstring girders, where the labour of calculation is considerable. Mr. Airy's method, which is entirely new, and very interesting, consists in constructing a model of the structure, in which all the bracing consists of thin steel wires, very accurately adjusted as to length, so that when unloaded none of the bracing is subjected to stress. The structure is then loaded so as to bring the bracing bars into tension, when, on being pulled, each of the bracing bars will give a musical note, the pitch of which depends on the stress. To ascertain this a free wire, precisely similar in size to the bracing bar, is suspended in a frame and cut off to the same length as the bracing bar by a sliding bridge. The free string supports a small scale pan, and this scale pan is loaded with weights, till its note corresponds with that of the bracing bar, the stress on which is required. This was determined by ear with the greatest accuracy, the effect of ½ oz. in 80 oz. being clearly perceptible. The tension of the bracing bar was thus measured by the weight in the scale pan of the free string, and the process is repeated for every bracing bar in the structure. The determination of the thrusts is made by a differential

process, thus:—A uniformly distributed load was applied on the girder, and the tension of every tie ascertained. Then a travelling weight was introduced, in addition, and hung at any one point, and the tension of every string was again taken, the difference of the tensions in the two cases being the thrust or tension due to the given travelling load. This beautiful acoustical method will no doubt be frequently employed, and for practical purposes leaves little to be desired. It does not, however, entirely get over the difficulty of ascertaining the effect of the rigidity of the arched boom of bowstring bridges. In the experiments Mr. Airy has made he has found the tension or thrust of every string to be proportional to the weight causing it, and the effect of several weights to be equal to the sum of the effects of the weights separately, and this is a confirmation of the accuracy of the method.

Liquid Fuel for Steam Boilers.—Capt. Selwyn, R.N., read a paper on this subject, before the Institute of Naval Architects, advocating the use of creosote, or "dead earth oil." This hydrocarbon does not inflame below 240°, and being heavier than sea-water, was, in his opinion, free from the dangerous properties which militated against the use of petroleum as a fuel for steam ships. The present price of creosote is 13*s* 9*d*. per ton. Its present production in the British Islands, as a waste product, probably reaches 60 million gallons annually. In heating power Capt. Selwyn estimates 1 ton of creosote to be equal to 3 tons of coal, and he stated that an ordinary Cornish boiler had been at work, night and day, since Christmas, doing more duty with 230 gallons of liquid fuel per day, than it had previously done with 3 tons of coal. The evaporation of water amounted to 23 lbs. per pound of fuel. In another instance a still higher efficiency was reached. Mr. C. J. Richardson has formed a theory that the water, or steam, introduced with the liquid fuel, and which seems necessary to its successful use, is decomposed, and the heat of combustion of the hydrogen added to that of the liquid hydrocarbons. He has constructed a grate, in which he says the decomposition of the water, and the burning of its gases, can be seen. It is difficult to conceive that any additional heating effect can be gained in this way, but it is the theory of one who has worked earnestly and practically at the question, and whose experience has led him to believe that "within twenty years, a locomotive or marine engine using coal or coke as fuel, will be looked upon as a curiosity, a relic of the olden time, as well as a rare piece of stupidity."

Gun-boat "Staunch."—Messrs. Stephenson have constructed a small gunboat, to prove that heavy guns may be carried by small craft for harbour defence, without incurring the disadvantages of unseaworthiness which so much marred the usefulness of the older gunboats. The "Staunch" is only 150 tons displacement, with a mean draught of 6 ft. She carries a 12½ ton Armstrong gun, which can be raised from or lowered into the hold by a donkey engine actuating four screws simultaneously. A screen of iron plates sufficiently strong to protect the men working the gun from rifle shot, is constructed across the bows, but the vessel is otherwise unarmoured. The vessel has twin screws, and the gun is trained by turning the vessel.

Governor adjustable to various speeds.—In the *Engineer* for April 24, will be found a paper by Professor Rankine on a governor for steam engines,

combining the properties of isochronism and adjustability to various speeds whilst in motion.

Dynamometer.—M. Hirn, whose researches in Thermodynamics are well known in this country, has described to the French Academy of Sciences a new form of dynamometer for ascertaining the power consumed by machinery.

Gas for Steam Boilers.—Gas is being used to some extent in London, for generating steam in small boilers. In the Thames granaries it is thus used, the steam being raised from cold water in twenty minutes, and maintained by a single burner. The cost is trifling, and labour and space are economised. A boiler on this principle was recently exhibited at the *soirée* of the Institute of Civil Engineers, the burners being on Bunsen's principle.

Flying Machine.—Mr. Wenham stated, at a recent meeting of the Aëronautical Society, that one of its members, Mr. Spencer, had already constructed an apparatus, by the aid of which he had raised himself from the ground level, and performed a horizontal flight of 100 feet.

Flow of Solids.—We alluded some time since to M. Tresca's researches on the flow of solids, and can now refer our readers to some very interesting diagrams of the appearance of solids when forced through apertures, appended by M. Tresca to a paper published in the *Transactions of the Institute of Mechanical Engineers*, and reproduced in *Engineering* for May 1.

Spring Buffers for Ships' Cables.—Mr. Saunders has applied, and apparently with success, springs to absorb the *vis viva* of ships riding at anchor, and to ease the strain on the cables.

Balanced Rudder.—Mr. C. W. Merrifield proposes, in twin screw vessels, to cut away the dead wood below the screw bosses, and to substitute, for the ordinary pair of rudders, a single balanced rudder in the centre line of the ship, and supported only at the top. To effect this, the rudder spindle is enlarged into a trunk, and rests on rollers.

MEDICAL.

Bacteria in the Kidneys, etc.—At the meeting of the French Academy, on May 6, a sealed packet, containing a memoir of M. Béchamp's on this subject, was opened. The author describes the presence of these organisms in the kidneys, liver, pancreas, etc., and he concludes that "it is impossible to explain the fact otherwise than by supposing spontaneous generation to have taken place."

The Synthesis of Neurine.—M. Wurtz's recent experiments demonstrate, to satisfaction, that the neurine obtained by him by a synthetical process, is identical with the neurine usually obtained from cerebral matter. He has since obtained chlorhydrate of neurine by synthesis, in long deliquescent needles, which he states is the form of the same salt prepared from brain matter. The synthetically prepared neurine is chlorhydrate of trimethyl-oxethylammonium. For a lengthy account of M. Wurtz's latest enquiries, vide *L'Institut*, No. 1792.

The Vitality of the Blood-Cells is the title of a memoir presented to the Academy of Sciences of Vienna, by Herr Ed. Hering. The author's observations have been conducted on the blood-globules of Batrachia, and they have shown him the passage of these blood-cells from the blood-vessels into the lymphatic canals. Herr Hering discusses fully the results obtained by Cohnheim and Recklinghausen, results which have lately received so much attention in our Medical Journals—and he concludes that the swelling of the lymphatic glands provoked by phlegmonous inflammation is not due, as Cohnheim alleges, to a hyperplastic operation for the production of new lymphatic cells, but is the result of the accumulation in the glands of the white cells which pass into them from the blood-vessels.—Vide *L'Institut*, May 6.

The Strength of Rattlesnake-poison.—Dr. Mitchell, who has conducted numerous experiments upon the strength and properties of this poison, states the following conclusions:—1. One-fourth of a drop of the venom is fatal to pigeons under the age of four months. One-eighth of a drop is frequently a fatal dose. 2. The venom is absolutely harmless when swallowed, because (*a*) it is incapable of passing through the mucous surfaces; (*b*) it undergoes change during digestion, which allows it to enter the blood as a harmless substance, or to escape from the digestive canal in an equally innocent form. 3. Twenty-four hours after it has been swallowed, the contents of the bowel contain no poison. 4. The rectum of the pigeon does not absorb the venom, and it causes no injury when placed on the conjunctiva of animals. 5. The venom passes through the membranes of the brain, and more swiftly through the peritoneum and pericardium. 6. When the venom passes through the peritoneum it so affects the walls of the capillaries as to allow of their rupture, and of the consequent escape of blood. The same phenomena appear on the bare surface of muscles thus poisoned.

A German Preservative against Cattle Plague.—An alleged preservative against this disorder is said to be now employed in Germany. The following are the prescription and the directions for using it: Take green crystallised chloride of copper, 8 grm., spirits of wine, 2 kilog., and dissolve. With this solution impregnate a pad of cotton, lay it on a plate, and set fire to it in the centre of the stable, turning the animals' heads towards the flame, so as to make them breathe the fumes. This operation is performed morning and evening, burning one pad for every three heads of cattle. At night, a spirit-lamp, filled with the solution, is lighted in the stable. To prevent accidents, the flame is surrounded with wire-gauze. The liquor is also administered internally, with the addition of 15 grm. of chloroform for the above quantity. A tea-spoonful of this is put into the animal's drink three times a day. As a further precaution, the litters are watered with the same solution.

The Value of Water-filters.—In the course of his recent admirable lecture on "Water-supply," at the Royal Institution, Professor Frankland made the following remarks on the efficacy of filters in the removal of organic germs from drinking water:—These refuse animal matters are known to contain that which is hurtful to human life. This hurtful matter is believed, on very strong evidence, to consist of spores, or germs of organisms, which are capable, under favourable circumstances, of producing in man such

diseases as cholera, typhoid fever, and dysentery. Now such spores or germs, endowed as they are with vitality, will be likely to resist the oxidising agencies which convert the rest of the animal refuse into carbonic acid, water, nitric acid, nitrous acid, and ammonia. For instance, if the contents of an egg were beaten up with water and poured into the Thames at Oxford, the organic matter would probably be entirely oxidised and converted into mineral compounds before it reached Teddington; but if the egg were thrown whole into the Thames at Oxford, it would, if it retained its vitality, be carried down to Teddington without any decomposition of its organic matter. There can be no doubt that the spores or germs of many organisms are in like manner capable of resisting for a long time the decomposing action of water. Now no practicable process is known by which these spores, once introduced into water, can be again removed or can have their vitality destroyed. Filtration will not do it; in fact, it is well known to engineers that water is often contaminated with visible suspended matter which cannot be separated by filtration; thus, M. Belgrand says, "Lorsque l'eau est troublée dans le fleuve, elle sort louche de nos filtres." And again, speaking specially of the London water supply, "Le mode de dégrossissage employé par les grandes compagnies anglaises, *très-convenable à Londres, où l'on ne boit pas d'eau, ne vaut rien à Paris, où les femmes, les enfants, les vieillards de la classe ouvrière n'ont pas d'autre boisson.* J'ai constaté par moi-même, et les ingénieurs anglais n'en disconviennent pas, que l'eau sort des filtres *très-chargée de matière organique.*" Again, in the account of his highly remarkable researches on vaccine and small-pox poisons, recently communicated to the Academy of Sciences, M. Chauveau says regarding the organic germs contained in these poisons, that they "ne se déposent jamais complètement dans les couches profondes du milieu ambiant, et passent à travers tous les filtres."

The Tactile Corpuscles.—M. Rouget believes he has demonstrated the actual structure of these bodies, which have so often baffled anatomists. He prepares the tissues by soaking them for some time in acidulated water. He then acts on the specimens with strong nitric acid; this, he says, stains the nerve-fibres, and not the adjacent structures. Preparations made in this way lead him to believe that the nerve-fibres are not simply coiled round the cone-like corpuscle, but absolutely enter its substance, and penetrate it.—*Comptes Rendus*, May 11.

Alum in Wine.—In a recent number of the *Gazette Médicale de Lyon*, M. le Dr. Barbier calls attention to the fact that many of the cheap wines, especially clarets, are largely adulterated with alum. In one instance which came under his notice, he had been treating a whole family for acute gastralgia, but eventually discovered that the affection of the stomach was due to the wine his patients had been using; on analysis this wine was found to contain as much as two drachms of alum in the bottle. In commenting on this case, the *Chemical News* (June 5) says: "We have ourselves obtained samples of so-called *pure* claret, which we have reason to believe contained a considerable quantity of alum; it is therefore evidently necessary for those who are accustomed to drink these wines, to have some guarantee of their purity."

Carbolic Soap.—Medicated soaps are much in vogue among foreign prac-

titioners, but, from what we have seen of their effects, we do not think them usually of any real service. We are glad to find, however, that Messrs. McDougall have introduced a carbolic soap, which is likely to prove of advantage in cases of cutaneous disease. We believe this firm is about also to manufacture a carbolic soap for rough household purposes. This would be very valuable because of its highly disinfectant qualities, and would be found well adapted for use in sick-rooms, the wards of hospitals, &c.

The Physiological Action of Substitution-compounds.—The researches of Dr. T. R. Fraser and Dr. Crum-Brown, published in the *Journal of Anatomy* for May, are of the highest interest and practical importance. By utilising the property of substitution, these chemists added methyl and other radicals to various alkaloids—such as morphia, brucia, strychina, codeia, &c. The result was in all cases to diminish in the most remarkable degree the active poisonous qualities of the alkaloids, and in one or two instances to alter their effects. The action, for example, of iodide of methyl-strychnium was very singular. It took no less than twenty grains of this substance to kill a rabbit, and the symptoms produced by it were not those of tetanus; there were no spasms or convulsions, death appearing to be caused by a general paralysis. It is an additional proof of the necessity for carrying on investigation in this field, that MM. Jolyet and Cahours, in a memoir read before the French Academy (June 1), state that in the course of several experiments on the ethyl, amyl, and methyl-compounds of aniline, they found that the addition of these radicals completely altered the action of the aniline. Aniline is usually regarded as a stimulant to the nervous system, and in overdoses gives rise to tetanic convulsions; but the ethyl-aniline causes death by paralysis.

The Indian and African Arrow-poisons have received a very careful examination at the hands of Dr. Beigel, who has published an excellent paper recording the results of his investigations. Having analysed the statements of the various Continental and English authorities, he details a number of experiments, which seem to have been conducted with the utmost scientific precision. He then describes the symptoms seen on administration of the poison: "The first of the phenomena, provided the quantity either injected or taken internally has been sufficiently large to produce an effect, is *the relaxation of the muscular system*, first noticeable in the altered expression of the countenance—this becoming apathetic, stupid, to which drooping of the upper eyelid soon accedes, partially or totally covering the bulb. The individuals under the poisonous influence sometimes, not being aware of this occurrence, are under the wrong impression of not being able to see, whilst their eyes are only closed. If told of the error they open their eyes, but are not able to do this as they would under normal circumstances, part of the eyeball remaining covered by the lid. When small quantities have been administered, the muscular system does not partake any further in the affection; but in case of larger doses, the control over voluntary movement may be lost entirely, the involuntary continuing, weaker perhaps, but regularly. My experiments have shown that certain parts or groups of the system of voluntary muscles are more affected than others; the upper extremities, for instance, being still capable of performing firmly these movements, while the lower are staggering and uncertain. Death only

occurs by urari if such a dose has been taken as to paralyse the heart, or the muscles of respiration—otherwise the heart continues to perform its duty in a regular manner; and, even in case of inactivity of the respiratory muscles, the animal will be restored to life and health if artificial respiration is performed." In reference to the African poison, which has not been so fully explained, Dr. Beigel remarks that it is a much more dangerous substance than the true urari.—Vide *Journal of Anatomy and Physiology*, (May).

The Use of Tobacco in Strychnia Poisoning.—Unless we greatly mistake, the advisability of using tobacco infusion in cases of poisoning by strychnia was first suggested by the Rev. Samuel Haughton, of Dublin. However, the following case, recorded in Bouchardat's *Annuaire de Thérapeutique* for 1868, further illustrates the fact that tobacco is a valuable antidote to strychnia:—"A girl of eleven years swallowed about three grains of strychnia accidentally. Strong tetanic convulsions appeared after half an hour. At the third hour the convulsive attacks, resulting in episthotonos, lasted one-and-a-half minutes, during which the chest was fixed, and suffocation impended. Emetics were tried without success, and then infusion of tobacco was repeatedly administered. During three hours she took, in sixteen doses, ʒii. of an infusion of tobacco (gr. xlv. tobacco to about ℥xxxv. boiling water). At the end of this time, *i.e.* about the seventh hour of poisoning, vomiting commenced, and recurred at intervals throughout the night, and part of the next day. The convulsions ceased after the first vomit, and did not return; and the patient was convalescent five days after the accident. M. Chevers is sure that this small quantity of tobacco would have acted before three hours if its toxic properties had not been neutralised at first by the condition of the nervous system induced by the strychnia."

Irritability of the Cardiac Terminations of the Vagus.—A Russian physiologist, M. Suchtschinsky of Moscow, has published an important paper on this subject. The following are the conclusions which he draws from his researches:—"1. Section of both cervical sympathetics produces no change on the irritability of the cardiac terminations of the vagus.—2. Complete removal of the influence of the cardiac motor nerves increases the irritability.—3. During decided increase of blood-pressure in the left side of the heart, through closure by forceps of the ascending portion of the aorta, irritation of the vagus can no longer stop the heart's action; if, however, the coronary arteries be closed, irritation of the vagus can arrest the heart.—4. Increase of blood-tension in the right side of the heart, by clamping the pulmonary artery, likewise annihilates for the time being the irritability of the vagus terminations.—5. Diminished arterial tension, whether produced by bleeding or paralysis of vasomotor nerves, produces at first increased, afterwards diminished irritability.—6. Insufficient supply of arterial blood to the muscular substance of the heart, in consequence of closure of the coronary arteries, increases the irritability; not, however, to such a remarkable degree as venous stagnation produced by closure of the three chief cardiac veins.—7. Insufficiently aërated blood greatly increases the irritability of the vagus, as Thiry, Cyon, and others have already shown. Hyperoxygenation of the blood often slightly diminishes the irritability of the vagus, but frequently also produces no change.—Vide *Centralblatt*, 1868, p. 34.

METEOROLOGY.

The Hurricane at Tortola.—In reference to an article on this subject by Professor Ansted, in a recent number of this Review, Commander Dix, of the R.M.S. *Conway*, writes to us to correct what he says are two erroneous assertions in the Professor's paper. The two assertions he objects to are:—(1) That in the Virgin Islands, "on the 29th of October last, at nine o'clock in the forenoon, the weather was fine, and the sky clear as usual, and the barometer stood at 30 inches;" and (2) "The direction of the wind, when the storm arrives, depends on the part of the storm that first reaches the place, but it shifts rapidly, and soon veers, in all cases backing round from E. by N. to W." Captain Dix states that the wind does not in all cases back round from East by North to West, but that the direction in which it veers depends entirely upon which side of the central track the observer happens to be. He has sent us a diagram, and a number of explanatory remarks, which appear to bear out his views. He then goes on to say:—"As regards the statement that the weather was fine as usual on the morning of October 29, I enclose extracts from the logs of some ships which were in the hurricane at or near Peter Island.—R.M.S. *Conway's* log, October 29, 1867: ('2 A.M., Squally, with rain, wind northerly, Bar. 29° 90′; 8 A.M., Same weather; 9 A.M., Increasing northerly winds, with *constant rain*; 10.30 A.M., Weather threatening, Bar. 29° 87′; 11.30 A.M., Blowing very hard, with furious gusts, wind N. by W., Bar. 29° 30′, falling rapidly.') Hurricane had now commenced on board R.M.S. *Conway*.—R.M.S. *Solent's* log, October 29, 1867: ('4 A.M., Wind variable from northward, light breeze, with heavy rain, Bar. 29° 87′; 9 A.M., Weather getting thick, with light rain, Bar. 29° 85′, wind N.N.W.') At 9 A.M. the *Solent* was going alongside the *Rhone*, to transfer cargo, passengers, &c.; but the log says, 'As the weather looked so bad, steamed out and anchored off Peter Island.' From these extracts, it appears that it was a very dirty morning, *i.e.* squally, with rain, &c., and the weather at 9 A.M. was *not* 'fine, and the sky clear as usual.' I have been induced to send you these remarks, because the statement that 'in all cases' the wind in a hurricane backs from right to left, *i.e.* from E. by N. to W., is liable to lead to mischief, as the safety of many lives and much valuable property often depends upon the readiness with which the captain of a ship can determine his position with regard to the path of the storm; and in the present day, with the knowledge we possess of the Law of Storms, no ship with plenty of sea-room and a good barometer ought to be caught in a hurricane. In the late hurricane, the R.M S. *Solent* and *Conway* were at position G (between Tortola and Peter Island), and the calm centre passed over them, lasting about twenty-five minutes. The R.M.S. *Tyne*, which was at anchor off Flanagan Island, hardly three miles south of position G, had no calm, the wind commencing about N.N.W., and backing round through W. to S. and S.E., the *Tyne* being just to the southward of Central Track."

MICROSCOPY.

Under this heading we have little of any interest to record of work done during the past quarter. Hartnack's immersion lenses appear to be getting into general use for work which does not require such high powers as the $\frac{1}{20}$ to $\frac{1}{25}$-inch objectives; but the subject of immersion lenses requires to be more fully worked out than it has been. We want the experience of those who have employed both forms of object-glasses, and who can fairly and fully state the respective qualities of the two forms.

A New Form of Condenser has been described in the last number of the *Quarterly Journal of Microscopical Science.* By the intersection at right-angles of two equal and similar half-cylinders, whose flat sides are in the same plane, a solid of a particular form is obtained. Dr. W. Robertson, of Edinburgh, who has described this solid, says that "were such a solid made of glass, and placed below the stage of the microscope, with its square side uppermost, rays entering its curved surfaces in directions parallel to the axis of the instrument would all be focalised into two lines, or narrow spaces, intersecting each other at right-angles. The light would increase in intensity towards the centre of the field. By stopping off a *diagonal* half of the square side, I think that a form of illumination would be obtained well adapted for exhibiting at the same time the longitudinal and transverse lines of *Pl. fasciola, Nav. rhomboides*, &c."

MINERALOGY, METALLURGY, AND MINING.

The Exhaustion of our Coal.—Still harping on this string, Professor Stanley Jevons delivered a recent lecture at the Royal Institution. After pointing out the dangers of our present position, and commenting on the impossibility of substituting electrical forces for power derived from combustion of coal, he states the following conclusions: 1. The power of coal is extending itself, and making itself more widely and deeply felt every day. It is more and more taking the place of wind, horse, or manual power, and is becoming the universal assistant.—2. We are naturally led every day to extend our consumption of so invaluable a substance, and experience shows that the more we use the more extensive are our augmentations.—3. Our consumption is already commensurable with our total supply; that is to say, we can form some notion how long our supply will endure with a stationary consumption.—4. As this consumption increases by multiplication, our national life becomes shortened, and it is apparent that the increase cannot go on very long at the present rate.—5. The moment we are forced to draw in, other nations, possessing far more extensive fields of coal compared with their annual consumption, will be enabled to approach and ultimately to pass us.—6. The exhaustion of our mines, as it will probably manifest itself within the next hundred years, will consist not in any stoppage of supplies, but an increase of cost, and the impossibility of increasing the consumption each year, as at present.

A Dolorite at Gleaston, in Low Furness.—Mr. E. W. Binney, at a meeting of the Manchester Philosophical Society, gave a description of a dolorite found in the above locality. He thinks this place requires to be further investigated. The specimens were examined by Professor Roscoe, of Owen's College.

British Minerals. — In a series of admirable communications to the *Philosophical Magazine*, Mr. David Forbes has described, among other important mineral productions, the stream-gold from the River Mawddach. A specimen of the dust washed from the bed of the river near Gwynfyndd, some eight miles from Dolgelly, contained small, flattened, elongated spangles of gold, the largest having the size of a pin's head, accompanied by abundance of fine black sand, supposed to be magnetite, but found to be titanoferrite, together with some small particles of quartz, slate-rock, mica, iron-pyrites, and galena. The gold was found to have a specific gravity of 15·79, and the following composition:—gold, 84·89; silver, 13·09; iron, 0·34; and quartz, 0·43. Several spangles had a peculiarly rich yellow colour, due to a thin film of sesquioxide of iron adhering to their surface.

Titanoferrite in Stafford.—Mr. Forbes, in the memoirs above referred to, describes the specimen of titanoferrite found by him in Stafford. He states that the basaltic or doloritic rocks of the South Staffordshire Coalfield invariably contain a small amount of a heavy black metallic mineral, strongly attracted by the magnet, and generally regarded as magnetic oxide of iron, whilst analysis showed it to be titanoferrite. Removed from the pulverised rock by means of a magnet, it was found, on examination, to have a specific gravity of 4·69, and a composition closely approximating to the formula $Fe_2O_3TiO_2$. The associated minerals, distinguishable only in thin sections when viewed under the microscope, are a triclinic soda-lime, felspar, augite, and a small quantity of what is probably seladonite, whilst pyrites, apatite, and a zeolitic mineral are likewise occasionally present. An examination of specimens of these basaltic rocks from each eruptive boss in Staffordshire, as well as others from the intrusive masses occurring in coalpits, showed that titanoferrite is invariably present, and is consequently an essential constituent of the rock itself. It is, moreover, that variety of titanoferrite which usually accompanies the eruptive rocks of Palæozoic age. The presence of titanium not only serves to characterise the basalts of this district, but likewise affords a means of detecting these rocks where altered by metamorphic action, and of referring tuffs, clays, etc. formed from them to the original source. Two instances furnishing proofs of this are mentioned.

A Black-diamond Drill. — The *Artizan* states that the Windsor (Vt. U.S.) Manufacturing Company are making a diamond drill quite different from the annular or tube drill (which formed a large central core and proved a failure). The new one has a solid drill-head, cutting the full size of the hole. This gives it greater strength and better facility for setting the diamonds, so as to hold their position with less liability to loosen. The diamonds used are dark, opaque, and imported for the purpose. They are worked by a small oscillating engine attached to the drill-carriage, and connected with a flexible supply-tube. Two men can carry one. It is quickly adjusted for work. The proprietors state that after boring over

500 ft. in granite, quartz, talc, and marble, with one drill-head, the diamond-points show no wear.

The Heating Power of Mineral Oils was the subject of a memoir lately read before the French Academy, by M. Deville. He experimented on petroleum and other mineral oils in large numbers. The mineral oil was submitted to distillation in a copper alembic furnished with a long serpent tube, and also with a thermometer. By means of this apparatus, the amount of distillate passing over at various temperatures was estimated. The danger possible by explosion was measured by the proportion distilling below 140°. The same experimental fact represents as well the loss which must be sustained to remove the explosive property of the oil. Another danger is encountered when the oils are enclosed in airtight vessels—explosion by dilation. The amount of space necessary to be left above a mineral oil is calculated from the coefficient of dilation. The data M. Deville has obtained from each sample are drawn, generally, from the following determinations:—Loss by heating to 100°, to 120°, and so on, by intervals of 20° up to 200°; this is expressed in percentages; composition of the oil—*i.e.*, percentages of carbon, hydrogen, and oxygen, obtained by combustion; density at zero, and at 50°, and coefficient of dilation; composition and density of the oil obtained by distillation, and density of the residue. In some cases the specific heat has been determined, and the latent heat at the mean temperature. M. Deville's memoir contained tables giving an immense number of experimental results.

The Science of Alloys.—In a recent lecture before the Royal Institution, Dr. Matthiessen, F.R.S., of St. Mary's Hospital, gave an interesting summary of the researches conducted by himself and other physicists on this important subject. After demonstrating, by means of a most ingeniously contrived apparatus, that the electrical and heat-conducting powers of the alloys follow the same curves, he stated that the analogy between the relation existing in this case and in some others may be shown experimentally, as follows:—When bars of alloys and their component metals are struck, a great difference will be found in the note produced; and in almost every case where the experiment has been made, the most sonorous alloy was found to correspond in composition, approximately, with that at the turning-point of the electric conducting-power curve. When wires of the same diameter of metals and alloys are broken by traction, those of the alloys will require a much greater force than their component metals; and it may be deduced, from what is known, that those alloys the composition of which corresponds to the turning-point of the conducting-power curve are more tenacious than any other alloy composed of the same metals. When spirals of wires of metals and their alloys are weighted to an equal extent, the alloys will be found, on removing the weights, to possess the property of resuming their original form in a much higher degree than their component metals. Here again the alloys corresponding in composition to those of the turning-point of the conducting-power curves are the most elastic. From what has been said, and from the experiments described, the conclusion may be drawn that the chemical composition of the practically-used two-metal alloys corresponds to those situated at the turning-points of the heat and electric conducting-power curves, and that if a two-metal alloy

of a special physical property be required, it would be as well to try that alloy the composition of which would correspond to the turning-point of the curve representing the electric conducting power of the alloys of the two metals.

Artificial Gems.—The *Chemical News* states that the base of these gems, as patented by the superintendent of the Royal Porcelain Works at Berlin, is a flux obtained by melting together 6 drachms of carbonate of soda, 2 drachms burnt borax, 1 drachm saltpetre, 3 drachms minium, and 1½ ounces of purest white sand. To imitate in colour, but of course not in composition, the following minerals, add to the flux the ingredients named in connection with each gem:—*Sapphire,* 10 grains carbonate of cobalt.—*Opal,* 10 grains oxide of cobalt, 15 grains oxide of manganese, and from 20 to 30 grains protoxide of iron.—*Amethyst,* 4 to 5 grains carbonate of peroxide of manganese.—*Gold Topaz,* 30 grains of oxide of uranium.—*Emerald,* 20 grains protoxide of iron, and 10 grains carbonate of copper.

The Chemistry of the Bessemer Process.—In a paper which a contemporary has translated from "Aus der Natur," an excellent account is given of the examination of iron, as it travels through the several stages of the Bessemer process. The description is given under the following heads:—1. The iron taken was dark-grey, graphitic, containing considerable silicon, very little phosphorus and sulphur, and much manganese; in every respect an excellent material for the Bessemer process. A small amount of copper was present, but not enough to either hinder the process or deteriorate the product.—2. At the close of the first period spoken of, all graphite had disappeared, partly by combustion, partly by combination with the iron; almost four-fifths of the silicon had been separated; all but a trace of sulphur had disappeared; the amount of phosphorus remained nearly the same; also the total amount of the copper, while its percentage was a little higher; much of the manganese was lost. The product at the close of this period was a pure white raw iron, containing not overmuch of carbon.—3. During the second period the removal of the carbon progresses rapidly, so also the still remaining silicon and manganese are rapidly disappearing, while again the copper and phosphorus remain almost the same. The product at the close of this period of only about seven minutes was a good steel; according to the common scale, steel No. 3.—4. At the close of the third period, a steel No. 7 was obtained. The addition of 6 cwts. raw iron gave a Bessemer-steel No. 6. The slags obtained at the various stages were also analysed; they always contained a great relative amount of silica, but, both before and after the second (or "boiling") period, remarkably little of ferrous oxide. During the last stages of the process, the percentage of manganese in the slag decreases, because most of the manganese is removed in the first period; so that the increase of slag during the last stages of the process can only add iron to it, *i.e.* reduce the percentage of the manganese. A little alumina and lime found in the slag is ascribed to the walls of the furnace.

PHOTOGRAPHY.

Photographing the Eclipse.—Next month will be signalised by a total eclipse of the sun, of almost the greatest possible duration. Astronomers are looking forward to this with considerable interest in connection with arrangements taken for photographing it. Major Tennant, of the Great Trigonometrical Survey, assisted by Captain Brandreth and three non-commissioned officers of the Royal Engineers, passed some time with Mr. Warren de la Rue, at his observatory at Cranford, practising to perfect themselves in Astronomical Photography before their departure for India. The expedition, originated by the Astronomical Society, will use a telescope constructed for the occasion by Mr. Browning, F.R.A.S. It is a reflecting telescope of the Newtonian form, by which the image is thrown out at the side of the tube, and is furnished with a mirror of silvered glass 5 ft. 9 in. in focus, and closely resembles that used by Mr. De la Rue. This instrument, set up at Guntoor or Masulipatam, will concentrate the light to an enormous extent, and as no attempt to magnify the image by interposing lenses between the mirror and the plate will be used, great rapidity may be expected in the exposing of the plate. It is calculated, as the totality will last nearly five minutes, not less than six negatives will be obtained in that time. Micrometic wires and other devices will be adopted to secure accurate register when putting the plates in position, and extraordinary care used to guard against possible chemical defects. The collodion, iodised with iodide of cadmium only, on the recommendation of Mr. De la Rue, will be sensitised in a bath of 30 or 35 grns. of silver to the ounce, developed with aceto-pyrogallic acid, and the image fixed with hyposulphite of soda.

Keeping the Silver Bath in good order.—Mr. O. G. Reylander, to achieve this desirable end, keeps his sensitising baths, when not in use, in the light, instead, as is usual, in the dark, and gives as a reason for adopting the plan, that any injurious matter contained in the solution may be at once detected by the reducing action of the light, when its removal by filtration can follow as a prompt and easy remedy.

Photographing Coast Scenery.—Photographs of this description can frequently only be obtained from a boat. To render this possible, M. Kruger has adopted the following plan. He has a tripod stand for his camera thirty feet in length. To this iron weights are attached by stout chains, so that, when it is planted in the water at a sufficient distance from the shore, the waves do not in any way disturb it, and a plate prepared in the boat under a dark tent, can be exposed with ease and without being shaken. In this way some excellent photographs have been taken, such as could not otherwise have been procured.

Filtering Bath Solutions.—Mr. A. Brothers, F.R.A.S., points out, in the *Illustrated Photographer*, a hitherto unsuspected source of contamination to the silver bath, arising from the use of white filtering paper, containing, probably, hyposulphite of soda. From what we have since heard on the same subject from various experienced photographers, we conclude that white filtering paper is one of those things which operators should avoid. It is said, upon tolerably good authority, that no white English-made

filtering paper is free from the hyposulphite. The only kind of filtering paper to be depended upon is the Swedish.

A simple Dry Plate Process.—M. Romain Talbot, at a meeting of the French Photographic Society, exhibited negatives on plates preserved six months before exposure, and which were said to have been prepared in the following extremely simple way. M. Talbot used Harnecker's collodion, sensitised in a bath containing about 50 grns. of silver to the ounce, and one drop of pure nitric acid. After sensitising, the plate is drained and washed, first in distilled, then in ordinary water, and then in distilled water again. After being dried at a temperature of about 90° Fahr. it is ready for use. The exposure required is about three times as long as a wet plate would receive under the same circumstances of subjects and light. To develop the plate is kept in a bath of distilled water about ten minutes, is then placed on the dipper of the silver bath and given four or five dips, and then subjected to the action of the following developer—sulphate of iron, 75 grammes; water, 1,800 grammes; glacial acetic acid, 45 grammes; absolute alcohol, 60 grammes. When the image is well out, wash thoroughly, and strengthen with a solution composed of pyrogallic acid, 1 gramme; distilled water, 225 grammes; glacial acetic acid, 10 grammes; to which is added nitrate of silver 1 gramme; distilled water, 48 grammes; glacial acetic acid, 1 gramme. Fix with hyposulphite of soda 1 gramme; water, 3 grammes; and to preserve the negative, coat it with gum.

Vitrified Caoutchouc.—This has been introduced in Paris as a substitute for glass in photography, the clearness, evenness, and transparency of which it possesses without its thickness, weight, or brittleness. It is to be used for various purposes, such as the transferring of collodion films, for excluding air or moisture from valuable silver prints, and for use in the carbon process. The films are as strong and flexible as paper, and can be manufactured in sheets of any required size.

A New Actinometer.—Dr. Vogel has introduced a new actinometer, which is so arranged as to expose sensitive paper to light under a ladder, formed by layers of paper resisting in varying and regular degrees, each one being indicated by its particular number, the action of the light. The instrument is used in a kind of frame or box, resembling an ordinary printing frame, but opening at the side.

Mounts for Photographs.—MM. Fordes and Davanne warn their photographic brethren against the use of mounts with gilt borders. These borders are made with bronze powders, which are mostly composed of bisulphide of tin, and may, from the mode in which it is manufactured, contain traces of free sulphur, the most minute trace of which, in the pores of the paper, would exercise an injurious effect upon any photograph it came in contact with. If particles of bronze powder be scattered on a photograph and their action under the influence of moisture be observed, the effect will soon become visible, in the shape of black spots surrounded by rings of yellowish white.

A Supposed Wonderful Discovery.—A photographer residing in Manchester, Mr. McLachlan, some few months since addressed letters to the Photographic Journals, in each of which he claimed to have made some wonderful discoveries, which would render the photographic process, hence-

forth and for ever, a matter of ease and certainty, do away with all the well-known chances of failure, and considerably reduce the quantity of materials required. Naturally enough, such statements created a sensation in the photographic world, and considerable anxiety was expressed as to when, where, and how such a grand secret would be divulged. After some little time had passed, filled with vain conjectures and eager appeals, Mr. McLachlan stated that he had no intention of selling this wonderful process or preserving it a secret, but that he wished it to be tested before it was published, and for this purpose he desired the formation of a committee to consist of gentlemen connected neither with the profession nor with the literature of photography. Two gentlemen were at length selected as repositories of the great secret—a member of the Chemical Society, who contributes to a photographic contemporary, Mr. Spiller of the Woolwich Arsenal, and Mr. Peter Le Neve Foster, M.A., Secretary of the Society of Arts. The report of these gentlemen, after a lapse of some time, was read at a meeting of the Photographic Society, in Conduit Street, Regent Street. In this it was very cautiously stated that experiments had been tried, and some of the expected conditions had been arrived at. At the May meeting of the Photographic Society Mr. McLachlan produced a long paper, which was read by the chairman. In this communication the chief conditions laid down as elements of invariable success, were: 1. The use of a discoloured deliquescent sample of nitrate of silver, about the nature of which the author could give, or at least gave, no information. 2. A collodion rendered slightly alkaline with caustic potash. 3. The use of a dark green dirty-looking protosulphate of iron for development. To make the bath complete it must be kept constantly in sunlight during three months of the brightest summer weather, and when used must be slightly alkaline. Of course, as the process requires three months for the preparation of the bath, little has been said practically on the matter, although it has given rise to a good many vague assertions and much theorising.

New Pocket Camera.—The *Illustrated Photographer* has called attention to the advantages of employing apparatus of an extremely portable character for the pocket, constructed to take pictures of a very small size, suitable for the enlarging process of printing. A consequent demand for such cameras has been replied to by Messrs. Negretti and Zambra, who have introduced an apparatus for landscape photography, the whole of which may be carried in the pocket with the exception of the tripod stand, which forms a walking stick, such as we called attention to in our last photographic summary. The camera in question is made on the principle of the Kinnear, or bellows camera, and is for plates 3¼ inches square. It has a folding tail-board, on which, when the camera is up, a little japanned case for carrying the dark slides in, is placed, and there forms at once the focussing screen, and supplies a magnifying glass, fixed in the right position for focussing. A simple and effective ball and socket arrangement, with a clamp screw for fixing, is attached to the tripod, so that the lens can be depressed or elevated; and the legs of the stand, diverging from immediately beneath the camera, although light and portable, are not the less rigid and firm.

A New Stereoscope.—Messrs. Murray and Heath have introduced what they term a new "Panoramic Stereoscope," with slides of a peculiar kind,

being very long from top to bottom, and very narrow from side to side. The effect given to these slides in the instrument, is remarkably good, the objects appearing to stand out more round and distinct, and with a larger share of naturalness than we obtain in the ordinary stereoscope.

New Lenses.—Mr. Ross constructed for the Abyssinian expedition a doublet lens; the diameters of the combinations were three inches and a half, and the equivalent focus four feet. This startling novelty played its allotted part perfectly. Another doublet of the same focal length was constructed by the same eminent optician for the Belgian government, the combinations of which monster lens are eight inches diameter! Mr. Ross is now completing the largest portrait lens ever made in this country, for the Indian government. The diameters of the components are ten inches! Another novel doublet lens has also been constructed by Mr. Ross, for Mr. Stuart, the well-known photographer. This is for interiors and sea views. It is six inches focus, and will cover a 4×3 plate, sharp to the edges.

PHYSICS.

The Contraction of bodies during Solidification.—In the course of a discussion which took place at the Chemical Society, some time since, consequent on the delivery of Mr. Chance's lecture, Mr. David Forbes, F.R.S., stated that Mr. Chance, at his suggestion, compared the measurement of the modern frames used for making the moulds for casting certain blocks of basalt, with the blocks so prepared when cold, and it was ascertained that no difference of size existed. From this it was inferred that molten basalt neither expands nor contracts during solidification. In reference to this conclusion Mr. A. Tribe writes a letter to the *Chemical News*, of March 27. In this he states, that contraction may occur in various substances, and yet manifest itself not by any diminution of size, but by the formation of cavities in the interior. He advances certain instances in proof of his views.

"*Melting Metal in a Handkerchief.*"—This old and popular experiment is so often performed, both by lecturers and amateurs, that the following improved modification of it, suggested by Mr. Woodward, of the Birmingham Midland Institute, deserves notice:—Two or three pounds of fusible alloy are melted, and run into an evaporating dish; when cold, a handkerchief is stretched over the smooth convex form thus obtained, and the mass may then be melted over a Bunsen's burner in the course of a few minutes; on piercing the handkerchief the melted metal runs out, and may be received in a mould.

The Refraction-Equivalents of Substances.—Those who wish to read a short and intelligible paper on the results of the most recent inquiries on this subject, and to learn how *every substance has a refraction compounded of the refractions of its constituents*, should consult the reprint of Dr. J. H. Gladstone's lecture, in the *Journal of the Royal Institution.* The lecture was delivered on the 24th of April, and is already published in "proof."

Explosion in Paraffin Lamps.—We are glad to see that this point formed the subject of a paper which was read before the Chemical Society, at its meeting on the 4th of June, by Dr. B. H. Paul. The author pointed out

that there was considerable difference of opinion as to what should be regarded as the firing point; whether it was to be the temporary firing of the first small portion of oil vapour given off, or the permanent firing of the oil itself. Between these two results there might be a difference of from ten to twenty degrees Fahrenheit, according as the oil was tested in a shallow open basin, or a partially-closed vessel. In reference to the influence of the degree of inflammability of mineral lamp oil on the possibility of accidents occurring in the use of this material, it was shown that the mere volatility of the oil was not the only point to be considered, and that, apart from misuse and carelessness, the construction of the lamps in which it was burnt was of considerable importance. To illustrate this, a lamp filled with what is commonly known as spirit or naphtha (the most volatile portion of petroleum or paraffin oil), was kept burning during the meeting. This lamp was so constructed, that there was no communication between the flame and the oil reservoir, except through the tube containing the wick, and consequently there was no chance of oil vapour or an explosive mixture of it with air coming in contact with the flame, so as to cause accident. Other kinds of lamps, in which there is free communication between the oil reservoir and the flame, afford less security, especially when the oil used in them vaporises at a low temperature.

The Silvering of Mirrors.—Those who know anything of Liebig's researches are aware that, for many years past, he has been engaged in trying to find a simple and satisfactory method of silvering glass for mirrors. After a long series of experiments, he has finally adopted the following process for silvering glass. The solutions employed are:—1. One part of fused argentic nitrate dissolved in 10 of water; 2. (*a*), commercial nitric acid, free from chlorine, neutralised with ammonic sesquicarbonate, and diluted to sp. gr. 1·115; or (*b*) 242 gr. ammonic sulphate dissolved in 1,200 c.c. water (sp. gr. 1·105 to 1·106); 3. Solution of sodic hydrate, sp. gr. 1·050, prepared from sodic carbonate, free from chlorine; 4. 50 grm. white sugar candy dissolved in little water, 3·1 gr. tartaric acid added, the mixture kept boiling for one hour, and diluted to 500 c.c.; 5. 2·857 gr. dry cupric tartrate, covered over with water, and solution of sodic hydrate gradually added till solution has taken place, and solution made up to 500 c.c. These solutions are mixed in the following proportions:—1st, 14 vol. of 1, 10 vol. of 2, and 75 vol. of 3=99 vol. of (A) *silvering solution*; 2nd, 1 vol. 4, 1 vol. of 5, and 8 vol. of water =10 vol. of (B) *reducing solution.* The *silvering mixture* is then made by diluting 50 vol. of the silvering solution (A) with from 250 to 300 vol. of water, and adding 10 vol. of the reducing solution (B). If ammonic sulphate has been employed for solution (A), the liquid, after mixing the three ingredients, must be allowed to stand three days before being used; the clear liquor may then be drawn off.—*Ann. Chem. Pharm. Suppl.*, v. 257.

Lighting Street Lamps by Electricity.—The *New York Times* contains an account of a simple but ingenious machine for this purpose, which it is proposed to employ in the American cities. It is a simple, small machine, placed in each lamp-post and connected by insulated wires with a central point, where the operator can, by simply starting the clock-work attached to the batteries, at once open the cocks in each lamp, and light up a whole city in the twinkle of an eye, or put out the lights at his pleasure. It

said, that 38,000 dollars is the estimate for labour and lighting of the city street lights. The labour and the amount of gas that would be saved in the time allowed for lighting and putting out, and the amount that is now used on bright moonlight nights, constitute an aggregate which no doubt would more than pay for the whole expense of introducing the improvement for the first year.

An Improved Voltastat.—At the meeting of the Chemical Society (April 16), Professor Guthrie described and exhibited an "Improved Voltastat," by which the current of a galvanic battery may be maintained perfectly constant and regular by a self-acting arrangement, which will become intelligible by the following description:—A vertical glass cylinder of about the size of a test tube is charged with dilute sulphuric acid, with a layer of mercury below occupying about one-third of its total contents. Partly immersed in the acid liquid is a pair of platinum electrodes insulated by glass fused upon the wires at that portion which passes through the cork stopper of the jar, and a comparatively wide glass tube, open at both ends, is fixed in the same cork, with its lower extremity dipping below the level of the mercury, whilst another delivery tube with bulb and capillary orifice provides for the slow escape of the mixed gases resulting from the electro-decomposition of the water. This apparatus having been placed in the battery circuit, say of three Bunsen cells, evolves the oxyhydrogen gas with a rapidity which may be easily regulated by the size of the aperture; if, then, the activity of the battery is increased, the larger volume of gas, unable to escape, exerts a greater degree of pressure upon the liquid contents of the cylinder, and the mercury is forced up the open tube, whereby the column of liquid descends and smaller surfaces of the platinum plates are left immersed, and the power of conduction is to a corresponding extent lessened. In this manner the author states that he found no difficulty in maintaining a perfectly uniform current for a period of six or seven hours, and any required adjustment could be made either by altering the size of the apparatus or of its component parts. By collecting the gases evolved this little arrangement could also be made to serve as a voltameter.

Can Electricity travel through a Vacuum?—This is answered in the negative by the results of recent inquiries. M. Alverguiate, of Paris, has constructed a new apparatus for proving that electricity cannot pass through an absolute vacuum. Two platinum wires are inserted into a tube so that their free ends are within about one-eighth of an inch of each other. The air is then exhausted from the tube by means of a mercurial column, after which the electric spark will not pass from one wire to the other.

Relation of Magnetism to Atomic and Specific Weight.—In a paper published in a late number of the *American Journal of Mining*, by Dr. P. H. Van der Weyde, the author establishes some very interesting points in physics. He says, "When we divide the specific gravity of the different metals, respectively, into their atomic weight, we obtain quotients, which indicate relatively the position of their actions." He then shows that these quotients have a very remarkable relation to the magnetic properties of the metals, and he supplies a long and useful table of reference. The following are a few of his observations, that may show the interest of the subject inquired into. 1st. The five magnetic metals have all quotients below 4.

2nd. The so called non-magnetic metals have all quotients above 4. There is, however, one exception to this rule, in the case of copper, of which the respective specific and atomic weights are 8·8 and 31·7, of which the quotient is 3·602; but then it is probable that the atomic weight of copper needs correction, and should be doubled to 63·4, in which case the quotient would be 7·204, and it would then fall among the other non-magnetic metals. 3rd. The quotients are the smallest for those metals which are the most permanently magnetic, even at high temperature, and *vice versâ*.

Polar Magnetism.—An essay on Polar Magnetism was recently read before the American Institute, and has been reprinted by the author, Mr. John S. Parker, who has favoured us with a copy. This pamphlet is a very clear exposition of a very difficult subject. Mr. Parker thinks that the cause of the variations of the compass, which some have attributed to the oscillation of the earth, is really due to the revolution of the magnetic pole around the North Pole, a revolution which is generally completed in about six hundred and forty years. There is one point in Mr. Parker's paper to which we would make exception, and that is his attempt to explain gravity. This is trying too far.

ZOOLOGY AND COMPARATIVE ANATOMY.

The Salivary Apparatus in Edentata.—M. G. Pouchet laid a memoir on this subject before the French Academy, at its sitting on March 30 last. The general conclusion which his researches would appear to warrant is that in these animals the salivary glands are more complex than usual, and that the pouring out of the saliva is not involuntary, but is directly under the control of the animal's will. The excretory ducts of the salivary glands of Edentata are, he states, very large, and are two in number, for each gland. In some of the genera the duct expands into a capacious sac. This sac is lined with a layer of voluntary muscles. The fibres arise from those of the mylo-hyoid muscle, and are arranged spirally, something like those seen in the heart. There are also valves which, when the sac contracts, prevents the regurgitation of the liquid towards the gland. In the ant-eaters, however, this arrangement is absent. The excretory ducts are certainly considerably dilated, but there are no valves, and the secretion is discharged through the combined action of the mylo-hyoid muscle and the tongue.

Are there Two species of Horse?—The researches which M. Sanson has lately carried out, and which are published in part in the *Comptes Rendus*, Tome LXVI., No. 137, have led him to the following important conclusions:—(1) There are in the East two specific types of horse, which have hitherto been confounded under the single name of Arab. (2) These are at once distinguished by their craniological character, and by the number of their vertebræ, as well as by other peculiarities. (3) They are both Brachycephalic, but in one the frontal is flat, the nasal bones are rectilinear, and there are *six* lumbar, seven cervical, eighteen dorsal, and five sacral vertebræ; the other has the frontal convex, the true nasal bones slightly curvilinear, and has only *five* lumbar vertebræ, the remaining vertebræ

being the same as in the first; the lumbar vertebræ are not only less in number, but have peculiarities of transverse apophyses and mode of arrangement. (4) These two Eastern types appear to have had distinct geographical origins. (5) The type with six vertebræ appears to be Asiatic, whilst the other, like the ass and the zebra, with only five vertebræ, would appear to be of African origin.

Trichinæ and Trichinosis, is the title of a memoir recently transmitted to the Academy of Sciences, by M. Colin. The author describes some experiments which confirmed the facts already published. One point is of importance, as it confirms observations of Fuchs and Pagenstecher—viz., that it is only in mammals that the trichinæ are enabled to pass into the muscular system, and remain embedded there, preserving their vitality.

Starch in the Yolk of the Egg.—Our readers will remember that we some time since called attention to M. C. Dareste's remarkable discovery of this fact. M. Dareste has since given a more detailed account of his observations, and has described the means employed by him in isolating the starch-granules. First he washes the yolk rapidly with ether, to remove the fatty matter. This should be done quickly, so as to avoid coagulating the albuminous substances. Then he washes it with water to remove albumen, and sugar, and suchlike matters. Finally, he treats the residue with acetic acid—an operation which extends over three months. During this time an extremely delicate precipitate forms, which is in great part composed of starch-granules. The microscopic and polariscopic examination of this precipitate proved beyond all question that starch-granules were present. This fact, says M. Dareste, adds to the analogy which is thought to exist between the egg of animals and the seed of plants.

The Development of Mites.—One of the longest and most important zoological memoirs which have for some time been published in the *Comptes Rendus*, is that which appears in the number for April 20, from the pen of M. Robin. It deals especially with the genus *Sarcoptes*, but the whole subject of the development of the *Acarea* is treated of. We could not attempt to give an abstract of this paper, so numerous are the details; but we may mention that M. Robin describes four stages in the metamorphosis of these curious members of the class *Arachnida*, viz.—(1) The egg stage; (2) the stage of hexapod larva; (3) that of octopod asexual nymphs, and (4) the stage of sexual males and asexual females. Finally, there is a fifth stage or moult in the production of the fully-developed sexual female.

A new Chinese Pheasant has been described by M. Milne Edwards. It comes from the interior of China, and is styled *Crossoptilon Drouinii*. It was sent by M. Dabry to M. Soubeiran, and was presented to the Museum of Natural History of Paris, by M. Drouin de l'Huys, whence the specific title. It is distinguished from *C. thibetanum* and *C. auritum* by various characters, not especially by its plumage, which is an uniform white.

Production of the Sexes in Bees.—The old stock illustration of the force of food in producing peculiarities of animal structure, viz. that of the production of sex in the bee, by the supply of a particular form of nourishment, has received a deathblow in the researches of M. Sanson. In a paper quite recently published, he narrates numerous experiments which prove beyond question that the food has nothing special to do with the production of sex,

which, in point of fact, as worked out by Herr Bastian, depends on the supply of zoosperms.

The late M. Serres, with whose many fine essays on Palæontology our readers have from time to time been made familiar, has bequeathed to the French Academy a sum to be devoted to a triennial prize of the value of 60,000 francs, to the best memoir on "General Anhyology."

The Egg of Trematodes.—In a memoir lately read before the *Royal Academy of Belgium*, by M. Ed. Van Beneden, the author points out that in the eggs of these Helminthes, the vitellus before development is divided into several cellules. From this he draws a conclusion which he does not seem to be aware was already drawn by M. De Quatrefages, that the ovum cannot, as Schwann formerly regarded it, be considered as a typical cell.

Nature-printed Butterflies.—We would call the attention of those of our readers interested in Lepidoptera, to an admirable collection of these insects now in the possession of M. Baillière of Regent Street. We call them nature-printed, but they are not so strictly. The wings of the insects are mounted in their natural state on paper, and the bodies are painted in sepia. The collection was originally made by some French amateur, whose name unfortunately is not known. The collection extends over eight 4to boxes (imitation volumes), the specimens being arranged four or five on a sheet, to the number of 4,000. The following groups are represented nearly completely:—Papilo, Sphynx, Bombyx, Noctua, Geometra, Pyralis, and Tinea. The work is said to have taken fourteen years to complete, and was evidently undertaken *con amore*. Nothing can exceed the beauty of the insects thus mounted.

Polymorphism of Anthozoaria and Structure of Tubipora.—Herr Kölliker has published a paper on this subject in the *Bibliothèque Universelle*, which the *Microscopical Journal* thus epitomises:—"The polymorphism of individuals, so remarkable among the Acalephæ, had till now no parallel among the other Cœlenterata. It is, therefore, a discovery as little expected as that of a veritable polymorphism, which Professor Kölliker has made among various genera of Anthozoaria and Alcyonaria. This polymorphism consists in this, that besides the large individuals susceptible of taking nourishment, and provided with generative organs, there exist also other smaller asexual polyps, which appear to preside essentially over the introduction of sea-water into the organism, and its expulsion, and which are, perhaps, at the same time the seat of an excrementitious secretion. These asexual individuals possess, like the others, a body-cavity divided into chambers by eight septa, and a pyriform stomach furnished with two apertures. They are entirely destitute of tentacles, and in place of the eight ordinary mesenteric filaments, no more than two are found applied over two consecutive septa. The cavity of the body of these individuals is always in communication with that of the sexual individuals, but the manner in which this communication is established is liable to vary with the genera."

Proceedings of the Zoological Society.—During the past quarter the Zoological Society has been busy enough, and several valuable papers have been read at its various meetings. Among these we may direct attention to the following:—On May 14, Professor Huxley read a memoir on the classification and distribution of the birds belonging to his divisions *Alecto-*

romorphæ and *Heteromorphæ*. By the latter term Professor Huxley proposed to designate the singular form *Opisthocomus*, which recent examination had convinced him must be arranged as a distinct group in the vicinity of the *Alectoromorphæ*.—At the meeting on April 23, a communication was read from Mr. C. Spence Bate, F.R.S., on a new genus of freshwater prawns, proposed to be called *Macrobrachium*. Four new species of this group were also characterised, and named *M. Americanum* (from Guatemala), *M. Formosense* (from Formosa), *M. Gangeticum* (from Patna), and *M. longidigitatum* (from an unknown locality). Remarks were added, referring to the singular distribution of these allied species.—At the meeting held on March 26, Dr. Murie read a paper on the supposed arrest of development of the Salmon (*Salmo salar*) when kept in fresh-water. Dr. Murie's remarks were mainly based upon fishes hatched in the Society's fish-house (from ova presented by Mr. F. Buckland) in January 1863—one of which had recently died and another was still living. Mr. F. Buckland exhibited and made remarks on other specimens of Salmonoids reared in fresh-water. Dr. Günther maintained that there was not sufficient evidence to prove that the ova from which these fishes had been hatched, were really those of *Salmo salar*. Judging by the specimens themselves, he believed them to be more probably young of some species of lake trout, or hybrids between two different species of *Salmo*.

The Nerve-cells in Fish.—Herr Stieda publishes, in Siebold and Kölliker's *Zeitschrift*, a memoir on the above subject. In this the *cells*, both peripheral and central, are described as bodies furnished with a vesicular spherical *nucleus*, and usually also with a *nucleolus*. They have no cell-membrane, and are consequently to be regarded as simple masses of protoplasm, which presents a finely granular aspect. These cells differ in size and form, the latter depending upon the number of processes given off, and which vary in number from one to four or five. The processes are merely continuations of the granular cell-substance, and, so far as the author has seen, are never connected with the nucleus. He regards the apparently apolar cells as artificial products, and he has never noticed any division of the processes, nor any connection between one cell and another. Besides these true nerve-cells, the central nervous substance presents numerous minute cellular elements, whose nature is not quite determined, but which have been termed "granules" from their resemblance to the so-termed "granules" in the retina. The author, contrary to an opinion he formerly entertained, is now disposed, with Gerlach and others, to regard these bodies as a kind of "nerve-cells."—Vide *Quarterly Journal of Microscopical Science*, April.

Good and Bad Silkworms' Eggs.—M. Brouzet has described a method of separating the good eggs from the bad ones. The process consists in treating the eggs first with nitrate of silver, and then submitting the eggs to a species of testing, by trying their different densities in water. We should certainly doubt the practical applicability of the process.

Butterfly Scales Characteristic of Sex.—We have received a copy of Mr. T. W. Wonfor's recent paper on this subject. Mr. Wonfor's observations are of great interest. We must refer our readers to the paper itself, published in the *Transactions of the Brighton and Sussex Natural History*

Society, for the details. We may remark, however, that Mr. Wonfor has demonstrated that in blue butterflies the battledore scales are characteristic of sex. These scales are always present in the males, but are never found in the females. He has also found peculiar tasseled sexual scales in the males of white butterflies. He regards these sexual scales as analogous to the "beard of man, the mane of the lion, and the plumage of certain birds." He gives the following as the best mode of preparing the scales:—"In obtaining the scales, I have found the best way to examine a wing is to lay it on a clean slide, place another upon it, and apply a moderate amount of pressure. Upon separating the slips, plenty of scales from either side, in their relative positions, will be found on the glass slides. If required to mount, a ring of varnish may be run round, and when nearly set, a glass cover being laid on the slide, it requires only a finishing coat when dry to make it ready for the cabinet."

Professor Halford's and Professor Humphry's Anatomy.—This, in substance, is the title of a pamphlet which has been forwarded to us from Melbourne. It is the reprint of a letter which appeared in the *Melbourne Age*, and was signed "Opifer." The writer, however, is readily identified, and those who wish to make themselves further acquainted with the subject, should write to the publisher of the *Age*. The title is full of bitter personalities, but contains many important analyses of the respective views of the two Professors. We do not care to go further with the controversy about "a new muscle in the Ape's leg." Enough, and more than enough, has been said upon it already, and we are glad to think that the spirit displayed when the matter was first discussed has now ceased to exist.

The Anatomy of the Lemuridæ.—The osteology of this group forms the subject of a valuable memoir which we have received from the author, Mr. St. George Mivart, F.L.S. Mr. Mivart mentions a fourth species of Indris, brought by M. Grandidier from Madagascar, and calls attention to the discovery, by the same explorer, of a new Lemuroid, with an accumulation of fat in the tail—which recalls to mind the well-known African sheep.

A Monograph on Hedgehogs.—At one of the late meetings of the Royal Academy of Vienna, Herr Fitzinger presented a memoir on the Erinaceæ, in which he described all existing species, and gave their habitat and synonyms. Three species, from North-east Africa, described by M. de Heuglin, are, it appears, new to science.

POPULAR SCIENCE REVIEW.

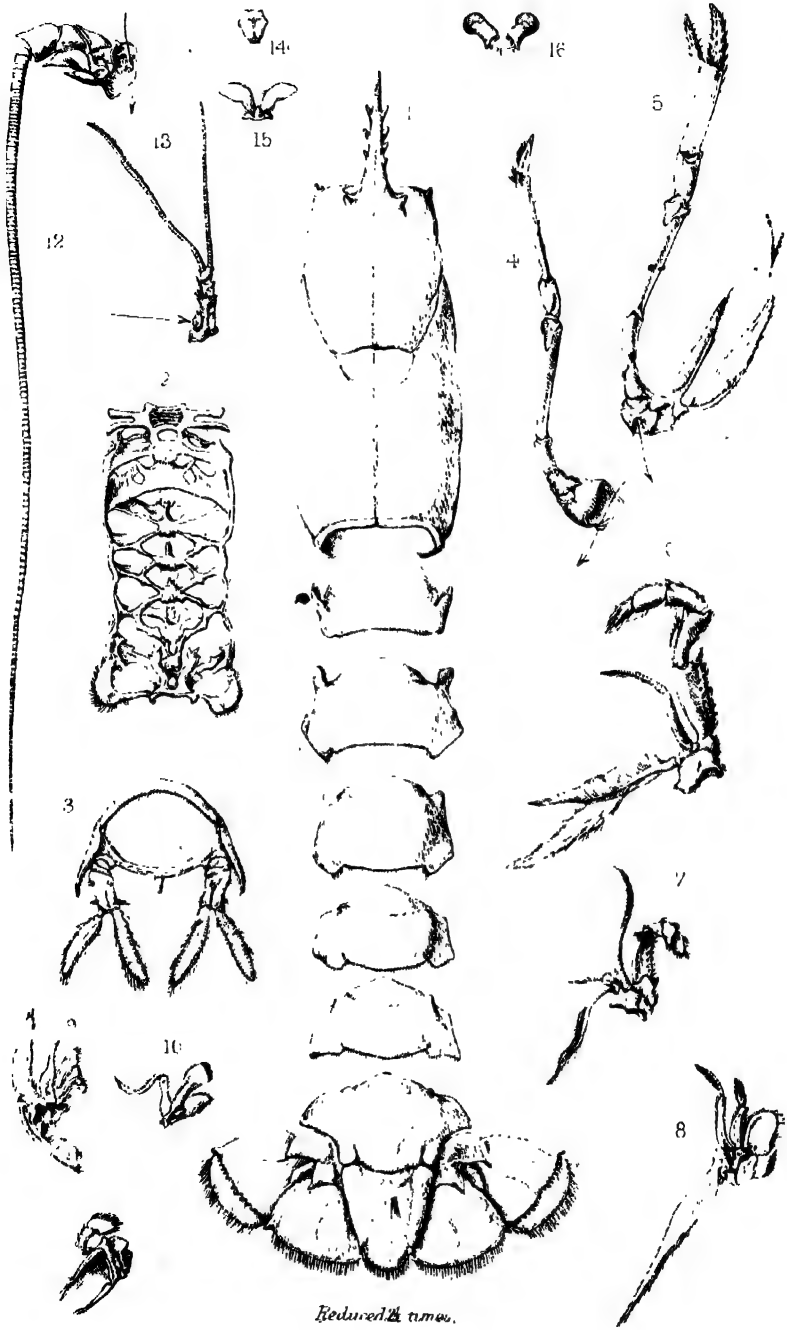
CONTENTS.—No. XXIX.

No notice can be taken of anonymous contributions. Contributors must write their names and addresses on the first page of MS. If accompanied with stamps, unsuitable manuscripts will always be carefully returned.

The Editor does not hold himself identified with the opinions expressed in contributions.

All communications to the Editor are to be addressed to 192 Piccadilly.

Plate XXXI



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W. West imp.

The Lobster

THE LOBSTER.

By ST. GEORGE MIVART, F.L.S.

Lecturer on Comparative Anatomy in St. Mary's Hospital.

OMNE ignotum pro magnifico is not more generally true than the converse: the readiest sources of information are too apt to be neglected—one of the best examples* of the important facts of animal organisation is constantly regarded from a gastronomic point of view only, while the food it offers to the mind is disregarded. This is the more to be regretted as the material and mental repasts can be simultaneously partaken of.

The first glance at the animal shows us a six-jointed tail, in front of which is a large solid mass (the *cephalo-thorax*, or head and fore-part of body), terminating, anteriorly, in a pointed process the (*rostrum*). On the under surface of the body we find a quantity of moveable appendages, legs, claws, jaws, and feelers, beneath the cephalo-thorax, and flat processes (swimmerets) beneath the so-called tail, which, however, is really not a tail at all, but is the *abdomen* or belly. The only representative of a tail is a median process (the *telson*) attached to the middle of the last joint, and terminating the whole body behind.

The Lobster, as we know, is encased in a hard structure—the shell; its legs, &c. (like our own), are all moved by muscles, but these, instead of winding round hard parts (as our muscles wind round our bones), are encased *within* the solid structures.

This shell is not composed of the same material as our own bones, nor is it horny, but it is formed of a nitrogenous substance, insoluble in alkalies, termed chitin, arranged in layers, between which salts of lime (mainly the carbonate) are deposited. In position the shell answers to our epidermis (or outer skin), and not to the scales of fishes, which latter

* Professor Huxley, in his lectures at the School of Mines, Jermyn Street, selects the Lobster as his type of the annulose division of the animal kingdom. The present writer wishes *in limine* to express his obligations to the Professor not only for many of the facts here stated, but in great part for the mode of presenting them also.

probably answer more to the deeper part (or true dermis) of our own skin.

Now, in order to understand this external skeleton, let us begin with the simplest structure, and take one of the joints (or *somites*) of the abdomen—the second from the head and fore-part of the body, *i.e.* from the cephalo-thorax. It consists of a curvex upper part (*tergum*) and a flatter inferior side (*sternum*); the angle of junction on each side of the tergum and sternum is produced downwards, and is termed the pleuron. The sternum bears the shallow sockets, each of which gives attachment to one of the swimmerets. Each swimmeret is made up of the single joint (*protopodite*, or root-footlet) which joins the sternum, and of two other equal-sized joints which hang from the single joint. The external one of the pair is termed the *exopodite*, or outer footlet; the internal one is called the *endopodite*, or inner footlet. If we examine the other somites of the abdomen, successively backwards, we shall find they all closely resemble the one described, except the last somite, and that differs (1) in having attached to it the terminal median piece before spoken of, the telson, which is merely a process and no somite; and (2) in having its swimmerets greatly broadened out, and each exopodite divided into two by a transverse joint. These broad swimmerets, together with the telson, form the expanded termination of the abdomen, which, by its forward projection through the water, drives the animal backwards. Thus we see that so far the lobster's body consists of a longitudinal series of parts which, in a certain sense, may be called "the same," the similar component parts being repeated in each; and we see that modifications in size or shape in even a process of segmentation does not destroy this "sameness," the divided exopodite of the terminal somite answering to the undivided exopodite of any other abdominal somite.

With the most anterior of these abdominal somites, however, we find a further change, the appendages which answer to the swimmerets of the other somites being here modified in the males into a pair of grooved processes, each like a marrow-spoon; in the female, into flexible, soft processes.

We come now to the cephalo-thorax, which at first seems to afford no sign of an essentially similar construction, a sort of furrow on the dorsal surface of the shell (or *carapace*) alone marking off an anterior portion, the head, from the rest of the complex structure.

If the ventral or sternal surface, however, be looked at, we then can detect evidence that the cephalo-thorax really consists of a number of somites fused, as it were, into one, and each somite has fortunately preserved its pair of appendages, different as we shall find these to be both from each other and from the swimmerets of the abdomen.

It may very naturally be asked, however, in what way these parts are known to be *really* similar though apparently different? In two ways: (1) By development, as in the young they all appear in the form of small processes, alike in size and shape; (2) By the examination of other animals belonging to the same group as the lobster, and thus it can be shown that parts which in the lobster's thorax are very unlike his swimmerets are, in other allied creatures, quite like them; short limbs, which in him are only limbs, in others are jaws also, while structures that in him are exclusively jaws, or feelers, in them are fully developed limbs.

But now proceeding forwards through the cephalo-thorax, just as we proceeded backwards through the abdomen, we come first to a pair of limbs which are very unlike swimmerets. Each consists of a series of joints, the basal one of which is the protopodite, indeed—but what are the rest? Here we must again have recourse to development, which tells us that in the young each limb had both exopodite and endopodite, but that as the adult condition is obtained the former aborts, so that the limb we are looking at consists really of a much elongated and segmented endopodite only.

The limbs forming the next pair in advance are quite like those just described, except that each sends upwards from near its base a delicate and altogether new structure, which is termed the *epipodite*, or upper footlet, and serves to keep the gills apart from each other. All these thoracic limbs, however, end in a simple point, but each limb of the pair next in advance, otherwise, like the preceding, exhibits a further complication at its end, in that it is furnished with a claw (*chela*). This claw is formed by an outgrowth from one of the distal corners of the penultimate segment of the limb, and then the ultimate joint bites against this production of the penultimate one. A limb so furnished is termed *chelate*. The next pair of limbs is quite like the last, and the one in front again is quite similar, except for the much larger size, for the fifth pair of thoracic limbs (counting forwards) constitutes the great claws.

We now come to a great change, for the three pairs of limbs in front of the great claws are termed maxillipedes (foot-jaws). Each of these consists of protopodite, exopodite, endopodite, and epipodite, and in the hindmost pair the endopodite shows by its limb-like structure its essential similarity to the locomotive endopodites behind it, while its basal joint is very hard, sharp, and cutting, like a jaw. The exopodite, though present, is small. Here terminate the appendages which belong to the thorax, what follow appertain to the head. The hindmost of these is termed the second pair of maxillæ, or jaws, and each such maxilla is of small size and delicate structure, but consists of a

protopodite, a small endopodite, and exopodite, and a large spoon-like epipodite, which serves a special purpose, and is termed the scophagnathite, or boat-like jaw. The next pair in advance is composed of the first maxillæ, and each such maxilla is small and delicate, and consists of the same parts, except that the epipodite is rudimentary. In front again are the two mandibles, and each mandible consists of a large expanded protopodite (a true crushing jaw) to which is attached a very small jointed endopodite—here termed a *palp*. The exopodite, as in the locomotive limbs, aborts. Between the two mandibles the mouth opens, and in front of it the sternal surface bends rather sharply upwards in what is termed the "cephalic flexure," in consequence of which the more anterior appendages are directed altogether forwards, and not downwards. The pair immediately in front of the bend is formed of the two long feelers (the *antennæ*), and each antenna consists of a protopodite and a long filamentary, much segmented endopodite, to the outside of the base of which a rudimentary exopodite (like a small scale) is attached. The pair of appendages next in front is formed of the antennules, and each of these consists of a protopodite bearing both exopodite and endopodite, and these are both much segmented and pretty equally developed, in the latter respect returning to the type of the abdominal appendages or swimmerets.

The most anterior pair of appendages of all (unless indeed they should turn out not to be true appendages) is composed of the two eye-stalks, each eye-stalk being a protopodite, elongated, and bearing an eye at its distal end. Besides the lateral appendages at the sides, the mouth is bounded anteriorly by a simple median piece (the *labrum*), and posteriorly by a bifurcating process termed the *metastoma*. The pleura of the thorax, instead of being only slightly produced (as before described, in the abdomen), are very much prolonged downwards, leaving a considerable space (the gill chamber) between the true body and the much bent-down pleura on each side of the former.

We are now in a position to see how great differences in size, form, and function may exist between parts which are essentially and developmentally the same. The antennule, antenna, mandible, foot-jaw, walking-leg, and swimmeret are all diverse modifications of one common structure. We have here an excellent example of what is called "serial homology."

Passing now to other points in the creature's anatomy, we will begin with the mouth, the situation of which has been already described. This leads by a short gullet to a large and globular stomach, divided into an anterior "cardiac" part and a posterior "pyloric" portion. These parts are so named by

analogy with the human stomach, and not because the anterior part is near the lobster's heart, which it is not. In the cardiac part is a complex, calcareous, grinding apparatus, moved by special muscles, and commonly known as the "*lady in the lobster.*" In the pylorus are fine hairs, which act like a strainer. A long and straight intestine continues from the stomach backwards, and terminates beneath the telson.

There is a cæcal salivary gland near the mouth, and the liver is a large ramified structure, not solid like our own, and there is nothing to represent a pancreas.

All the muscles of the body, even those of the intestine, are composed of striated fibres.

The blood is a slightly dusky fluid containing numerous nucleated corpuscles, which change their form with remarkable activity.

The heart is situated in the dorsal part of the thorax, and if the hinder half of the dorsum of the carapace be removed during life, it will readily be seen pulsating. It consists of a single chamber or ventricle suspended in a large sac, unfortunately named the *pericardium*, though it is quite a distinct structure from the part so named in man. The ventricle has three pairs of apertures so closed by valves as to readily allow the entrance of blood from the pericardium, but to hinder its regurgitation. It has three other pairs of openings, each of which is the commencement of an arterial trunk conveying blood all over the body. These arteries have valves at their origin, and ramify and end ultimately in capillaries, which open into what are called venous sinuses, because they are channels without any definite shape. The venous blood collects in a great sternal sinus, and thence passes up into the gills to be oxygenated, after which it proceeds to the pericardium to find its way into the ventricle. Thus the heart propels arterial or aërated blood to the body—not venous blood to the gills, as in fishes. The returning blood is not redistributed through the liver as in man, *i.e.* there is no portal circulation. There are no lymphatic vessels.

The breathing organs or gills are pyramidal bodies, each consisting of a central ascending stem with numerous horizontal branches, through which the blood circulates. There are twenty such structures on each side attached to the bases of the legs, and protected by the carapace as they pass up into the large chamber between the great bent-down thoracic pleuron and the true body. The gills are not ciliated, and thus require that the water bathing them should be incessantly renewed by other means. This is partly brought about by the very movements of the legs to which they are attached, and partly by the epipodites which ascend between the gills. The main agent,

however, is the scaphognathite, or boat-like jaw, on each side, which continually spoons out the water from the gill-chamber in front, and thereby causes a current to enter from behind.

The nervous system consists of a longitudinally-disposed series of different sized ganglia, connected together by commissural cords, and placed in the ventral region of the body.

Primitively there is a pair of ganglia to each somite, but the three first pairs fuse, in the adult, into a large cerebral ganglion placed in front of the mouth, and called the brain. From this a nervous cord passes back on each side of the gullet to the large post-oral ganglia, which is made up of six pairs of primitive ganglia fused together. Then follow five pairs of thoracic and six abdominal ganglia, all distinct, but connected one with another by a nervous band formed of the primitive commissural cords which have coalesced in the middle line.

No solid internal skeleton separates this nervous axis from the alimentary system, though reflections of the external integument (*apodemata*) pass inwards and more or less protect it. From this nervous axis all the nerves are given off, but none arise by two distinct roots like the spinal nerves of man.

The organs of sense known are but two, as no organ of smell has been determined, and the functions of the antennæ and antennules can only be speculated about. They are probably tactile organs, but of course *may* be the seat of senses to us unknown and inconceivable.

The two eyes are compound ones—that is to say, each has its surface divided into a great number of quadrangular facets, which are the external boundaries of conical club-shaped bodies separated from each other by pigment and connected with the optic nerve. The true nature of this eye is not yet determined, but it may probably turn out to have a very remarkable resemblance to that of the human retina.*

The ear is situated in the protopodite of each antennule, and consists of a small sac opening externally by a narrow cleft guarded by hairs. At the bottom of the sac is a prominence wherein the auditory nerve terminates, and on which are very delicate hairs with siliceous particles which have found their way in from the exterior.

A green gland exists at the base of each antenna, and communicates with a sac which opens externally on the protopodite of that appendage. This gland is said to be the kidney of the lobster.

Each individual is either male or female, and the latter may be distinguished by its deeper pleura and more hairy swim-

* This was pointed out by Professor Huxley in his Hunterian Course for 1868.

merets, as well as by the softness and flexibility of the first pair of abdominal appendages. The essential generative part (ovary or testis) in both sexes consists of a pair of elongated sacculated tubular glands with a transverse communication. They lie antero-posteriorly beneath the heart. An excretory duct descends from each gland, and is called in the female the *oviduct*, in the male the *vas deferens*. The duct in the female opens externally upon the base of the antepenultimate (last but two) thoracic appendage on each side. In the male it opens on the base of the last thoracic limb on each side.

The sexual product of the male (*spermatozoa*) has each three tail-like processes, but is nevertheless not locomotive. It becomes aggregated in packets (*spermatophores*) by a viscid secretion. A similar secretion attaches the female product (*ova*) to lateral appendages of the mother. In development, only a small part of the yelk divides, and gives rise to the membrane whence the embryo arises (*blastoderm*).

It is the ventral side of the body, *i.e.* that side of the body at which the nervous system is situated, which appears on the surface of the ovum. The various appendages successively appear as buds of similar form and size, and the thoracic limbs for a time have both exopodite and endopodite. No apertures ever appear in any way answering to the visceral clefts of the human embryo.

Such are the main facts concerning the form and structure of this highly interesting though common animal. It is interesting because it presents us with the most fully developed and complex condition of that type of structure to which it belongs. All crabs, shrimps, insects, scorpions, spiders, hundred-legs, &c., belong to the same type, but with more or less important modifications. The shrimps are almost the same in structure, but the crabs have the abdomen quite rudimentary, devoid of appendages, and tucked up on the under surface of the enormous cephalo-thorax.

In all insects, scorpions, spiders, and hundred-legs the antennules of the lobster are not represented.

In insects, the appendages which answer to the second pair of maxillæ of the lobster are united in the middle line, and take the name of *labium*. The three pairs of legs with which each insect is furnished answer to the maxillipedes of the lobster.

In the scorpions, the antennæ are chelate (as they are indeed in the king crab), and the palps of the mandibles, instead of being very small structures as in the lobster, are expanded into the large formidable-looking claws. Its four pairs of legs answer to the two pairs of maxillæ, the great claws and the first pair of legs of the lobster. The same may be said of the legs of the spider. The sting at the end of the scorpion's so-called tail, but real abdomen, is a modified telson.

Returning to the lobster, we may note sundry fundamental facts of structure:—

1. The nervous axis is ventral.
2. The central part of the circulating system is dorsal.
3. No solid internal structure separates the nervous centres from the alimentary canal.
4. The most anterior part of the alimentary canal bends towards and traverses the central axis of the nervous system.
5. The limbs are more than four in number.
6. There is no portal system.
7. In development, no visceral clefts appear.
8. The jaws are modified limbs.
9. In development the embryo does not present a longitudinal median groove.

In man, on the other hand—

1. The nervous axis is dorsal.
2. The central part of the circulating system is ventral.
3. A solid structure (the vertebral column or spine) separates the nervous centres from the alimentary canal.
4. The most anterior part of the alimentary canal bends away from the central axis of the nervous system.
5. The limbs are not more than four in number.
6. There is a portal system.
7. In development "visceral arches" appear separated by "visceral clefts."
8. The jaws are not modified limbs.
9. In development the embryo presents immediately a longitudinal median groove, which becomes the foundation, as it were, of the entire organism.

Now in these nine diversities of condition all crabs, shrimps, insects, scorpions, spiders, hundred-legs, and such-like creatures agree absolutely with the lobster; and all beasts, birds, reptiles, amphibia (*i.e.* frogs, efts, &c.), and fishes agree absolutely with man, and form together with him the great *Vertebrate* primary division of the animal kingdom. The lobster and its allies form together the great Annulose primary division of the animal kingdom.

No animal known to exist now, or ever to have existed in past times, presents us with any intermediate condition tending to bridge over the chasm yawning between the two so diverse types of structure.

Other types exist as distinct perhaps from either as they are from each other. One of these may at a future time form the subject of another zoological sketch.

DESCRIPTION OF PLATE.

FIG. 1. The animal viewed from above. The abdominal somites somewhat separated. R., *rostrum*; T., *telson*.

„ 2. The upper (inner) surface of the sternal part of the cephalo-thorax.

„ 3. The third abdominal somite separated and seen from behind. t., *tergum*; s., *sternum*; pl., *pleuron*; p., *protopodite*; ex., *exopodite*; en., *endopodite*.

One of the last pair of thoracic limbs of the male. p., *protopodite*; en., *endopodite*; d., mouth of vas deferens.

One of the antepenultimate pair of thoracic appendages of the female. p., *protopodite*; en., *endopodite*; ep., *epipodite*; g., gill; o., mouth of oviduct; ch. 1, penultimate segment of endopodite forming part of chela; ch. 2, ultimate segment of endopodite forming other part of chela.

„ 6. One of last pair of maxillipedes. p., ex.; en., ep.; as before.

„ 7. One of middle pair of maxillipedes.

„ 8. One of anterior pair of maxillipedes.

„ 9. One of the second pair of maxillæ. sc., the modified epipodite called *scaphognathite*.

„ 10. One of the anterior pair of maxillæ.

„ 11. One of the mandibles. p., rudimentary endopodite, here termed a "*palp*."

„ 12. One of the antennæ. ex., scale-like exopodite; r., opening of renal organ.

„ 13. One of the antennules.

„ 14. Labrum.

„ 15. Metastoma.

„ 16. Eyestalks.

WHAT IS WINE?

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WINE is the fermented juice of the grape, pure and simple; and if anything else has been added to it, the resulting liquid is not, strictly speaking, wine. Such a definition would, however, necessarily exclude the greater number of beverages drunk in Great Britain under the name of wine; but as this would be practically inconvenient, we may extend the above definition so as to include in it all fermented liquids, the basis of which is the juice of the grape, either pure or with such additions only as are believed to improve the durability of the wine.

This limitation would divide wines into two classes—the first consisting of pure natural wines, the second of all fortified wines. It must, however, exclude entirely all compounds of which grape juice forms but an unimportant ingredient, or that contain no grape juice at all; such as some of the vile decoctions manufactured at Hamburg, and imported to this country under the name of Elbe Sherry and Port; and also the different beverages known as British wines.

Grape juice consists essentially of an aqueous solution of grape sugar, fruit sugar, tartaric and malic acids, partly free, partly in combination with potash, vegetable albumen, and mucilage; sometimes a small quantity of an essential oil (imparting a peculiar flavour, as in the muscatel grape), together with a small amount of mineral substances, chiefly potassic chloride, and sulphate, and calcic phosphate. The skins and seeds of the grape contain albuminous substances, colouring matter, tannin, and a kind of fat; substances which are, under certain conditions, dissolved during fermentation, and which in their turn produce certain notable effects upon the wine.

For the purpose of wine making the grapes are first crushed, either by being passed between rollers or by being trodden by men. The pulpy mass thus produced is then placed in powerful presses, by means of which the juice is separated from the

greater part of the skins and seeds; and this expressed juice is called *must*. When white wine is to be made this juice only is taken. In the preparation of red wines, however, the skins and seeds are allowed to remain in the juice for from 3 to 20 days before pressing; since the juice even of red grapes would otherwise yield a white wine, the colour being imparted to the wine by the skins.*

The *must* is now put into large vats or casks, and there left. Soon it becomes turbid and evolves carbonic acid; and at the same time the growth of a peculiar kind of fungus, the yeast plant, may be observed in it. The *must* has begun to ferment. In order to start the fermentation the access of air to the juice is essential; but fermentation, once set up, goes on even if atmospheric air be entirely excluded. Most probably the air acts merely as a carrier of the spores of the fungus, which spores, finding the conditions necessary for their growth in the *must*, begin to germinate when brought in contact with it. The development of the yeast plant requires the presence of a nitrogenous as well as of a non-nitrogenous substance, the first of which is supplied by the vegetable albumen, the second by the sugar. During the growth of this fungus the albuminous substance becomes absorbed, and is made insoluble, while the sugar is in great part resolved into alcohol and carbonic acid. Fermentation then is probably nothing more than a vital process of the above-named fungus, by virtue of which it absorbs the sugar, converts part of it into cellulose, constituting the cellular membrane, and breaks up the rest chiefly into alcohol and carbonic acid, both of which substances are excreted again by the plant.

Fermentable sugar is a compound, the molecule of which consists of 6 atoms of carbon, 12 atoms of hydrogen, and 6 atoms of oxygen. During fermentation this compound molecule of sugar breaks up into 2 molecules of carbonic acid, each made up of 1 atom of carbon and 2 of oxygen, and 2 molecules of alcohol, each made up of 2 atoms of carbon, 6 atoms of hydrogen, and 1 of oxygen; or, in symbolic language,

$$
\begin{array}{ll}
C_6H_{12}O_6 \text{ breaks up into} & \\
\quad \text{twice } C\,O_2 & = C_2 \quad\;\; O_4 \\
\quad\;\; \text{,,} \quad C_2H_6O & = C_4H_{12}O_2 \\
\hline
 & C_6H_{12}O_6
\end{array}
$$

where C stands for 1 atom of carbon, H for 1 atom of hydrogen, and O for 1 atom of oxygen: the figure below to the right

* Except perhaps the dyer grape teinturier, which, like black currant, has a coloured juice.

denotes the number of atoms in the compound; the different symbols written side by side denote the compound made up by the different elementary atoms.

A definite quantity of the fungus, or yeast, as it is called generally, is, however, capable of converting a definite quantity only of sugar into carbonic acid and alcohol; after which the fungus loses its vitality and perishes. 1½ parts of dry yeast are capable of decomposing about 100 parts of sugar. Hence, if in a saccharine solution there is not a sufficient amount of nitrogenous matter present for the growth and nutrition of the necessary quantity of yeast, some of the sugar will remain unaltered; if, on the other hand, there is more nitrogenous matter than is necessary, part of this latter will remain unchanged.

Alcohol and carbonic acid are not, however, the only products of the fermentation of sugar; but there are produced simultaneously and invariably a certain proportion of glycerine and succinic acid, and probably also a variable proportion of some of the higher homologous * alcohols, as propylic, butylic, amylic, &c. &c.

The yeast plant, moreover, though the only substance inducing alcoholic fermentation in saccharine solutions, is not the only ferment capable of decomposing sugar. Under the influence of putrefying casein, for example, sugar yields lactic and butyric acids; and it is highly probable that a small part of the sugar in the *must* suffers a similar decomposition under the influence of the vegetable casein and analogous substances present in small quantities in the grape juice. The breaking up of the sugar into carbonic acid and alcohol, &c. &c., is, however, by no means the only chemical action going on in the fermenting *must*. During the first few days of the fermentation, when the evolution of carbonic acid is copious, atmospheric air is no doubt almost entirely cut off from the *must*, by the layer of carbonic acid gas constantly covering the surface. As soon, however, as fermentation becomes less energetic, atmospheric

* Among carbon compounds there are many that may be arranged in series, the successive members of which differ by an increment of CH_2, as illustrated by the series of alcohols and series of fatty acids:—

ethylic alchohol	C_2H_6O	acetic acid		$C_2H_4O_2$
propylic ,,	C_3H_8O	propionic	,,	$C_3H_6O_2$
butylic ,,	$C_4H_{10}O$	butyric	,,	$C_4H_8O_2$
amylic ,,	$C_5H_{12}O$	valeric	,,	$C_5H_{10}O_2$

The members of all such series, termed homologous series, bear a great resemblance to each other in general chemical characters, such resemblance being the greatest between those standing nearest to each other in the series, and getting less and less as their difference in composition increases.

air has access to it, and various processes of oxydation are set up. Some of the alcohol formed becomes oxydised into acetic acid; and most probably part of the albuminous and fatty substances of the *must* are converted into acids, homologous with acetic acid, as propionic, butyric, propylic, pelargonic, &c., belonging to the series of so-called fatty acids. At the same time a variety of essential oils, termed ferment oils, are frequently produced, to which the perfect wine often owes part of its aroma.

As soon as a moderate quantity of alcohol has been formed in the *must*, it effects great changes in the solubility of various constituents. Thus, bitartarate of potassium, being less soluble in alcoholic liquids than in water, begins to be deposited; and this precipitation keeping pace with the increasing amount of alcohol, the *must* becomes thereby less and less acid. On the other hand, the colouring matter of the skins, being soluble in spirit in the presence of acid, is gradually dissolved in proportion to the increasing amount of alcohol.

The progress of this first fermentation will, however, be greatly influenced by the temperature at which it takes place. If the temperature is low, fermentation proceeds slowly, and is accompanied by fewer products of oxydation; if, on the other hand, the temperature is high, fermentation goes on rapidly, and oxydation is at the same time augmented. Lastly, the quantity of sugar, as well as the amount of alcohol produced, exercises a considerable influence on the *must*. A *must* which contains more than 25 or 28 per cent. of sugar does not ferment so readily as when it contains less; while, if more than 12 per cent. of alcohol have been produced, fermentation is also to a considerable extent impeded. At low temperatures, indeed, it does not proceed at all; at a moderate temperature it proceeds but slowly, in which state of things great danger of excessive oxydation is incurred. On the Rhine and in most parts of France, the temperature during the time of vintage is not generally very high, and is frequently but little above the lower limit at which vinous fermentation is possible, viz. 7° C. The *must*, also, in these countries rarely contains more than 25 per cent. of sugar. Their wines, therefore, may be allowed to ferment thoroughly without fear of excessive oxydation; whence they retain little or no sugar, and are almost free from albuminous substances. In Spain, Portugal, and other southern countries, however, the temperature during the vintage is high, sometimes almost reaching the higher limit, viz. 36° C., at which vinous fermentation is possible, and being within that which is favourable to acetous fermentation; the *must* also frequently contains more than 25 per cent. of sugar. In these countries, then, it is often impossible to allow fermentation to proceed to its full extent; and it is frequently

necessary to check it altogether by the addition of spirit, thus bringing the alcoholic strength above the limit within which fermentation can take place. Such wines, therefore, retain part of the sugar* unaltered, as well as of the albuminous compounds; moreover, sufficient time not having been allowed for that gradual and slow action of the atmospheric oxygen necessary for the production of the odoriferous principles, these wines when young are almost devoid of the *bouquet* that distinguishes the wines of more temperate climates.

Unfortunately little or nothing is known concerning the temperature most suitable for fermentation, with a view to bringing all the good qualities of a wine to perfection, the temperature being left practically to the chances of weather and climate. It would seem, however, that a temperature approaching the lower limit at which fermentation is possible yields the most fragrant and the most durable wine; and there is little doubt that if the wine producers in Spain and Portugal allowed their *must* to ferment in cellars, the temperature of which was artificially kept low, by being in connection with ice pits,† a wine might be obtained which would keep without the addition of spirit, and would then really be a natural Sherry or Port, and at the same time be an excellent wine. On the Rhine, on the other hand, the temperature during vintage is frequently too low to allow of the thorough fermentation of a rich *must* before the cold of winter checks it entirely; and such wines have to be kept sometimes five or even more years in a cold cellar before they are fit for bottling. During the whole of this time a slow chemical action proceeds, by reason of which the sugar gradually disappears, and the albuminous matters are removed either as ferment, or by oxydation as above described. If in these cases the first fermentation were judiciously stimulated by means of a somewhat higher temperature, the time necessary for this after fermentation might no doubt be considerably shortened. But to return to our *must*. When the first fermentation is completed, the greater part of the sugar has disappeared, and in its place alcohol, glycerine, and succinic acid are chiefly found; 100 parts of sugar yielding about

48·5	parts of	alcohol
3·6	„	glycerine
0·67	„	succinic acid
46·4	„	carbonic acid

which latter escapes, however, almost completely.

* The sugar in the *must* is frequently increased by evaporating a part, and then remixing this with the rest.

† In many large breweries in Germany the stock of beer is kept during the hot season in vaults which are in connection with an ice cellar, by

Besides this ethylic alcohol, small quantities of some of its higher homologues, as propylic, butylic, amylic, alcohol, &c., as well as some of the fatty acid series, will likewise have been formed from the sugar; whilst a part of the ethylic alcohol will have been converted into acetic acid. At the same time the alcohol produced will have dissolved several substances from the skins and seeds, such as colouring matter and fat, the latter being thus brought within the oxydising influence of the atmospheric air. On the other hand, some substances previously in solution will have been thrown down as being less soluble in a spirituous liquor than in water, such as the bitartarate of potassium: the wine contains consequently less fixed acid than the *must*. Part of the alcohol, however, becoming oxydised into acetic acid, the sum total of free acid in the wine is not much less than it is in the *must*. The albuminous substances and mucilage have also in great part disappeared, partly by having been absorbed by the ferment, and separated in an insoluble condition with the yeast, partly by being oxydised into fatty acids, or changed into extractive matters, or, lastly, by being precipitated by the tannin.

Meanwhile the various substances thus produced have not been without chemical action on each other; the most important result of which is the production of a number of compound ethers* by the mutual action of the various acids on the several alcohols present. To these compound ethers, together with the ferment oils previously mentioned, the wine owes in great measure its smell and bouquet. This first fermentation usually lasts from two to six weeks; after which the wine is left on the lees till the following spring, and is then drawn off into a fresh cask, in which a slight secondary fermentation continues, sometimes for years; the wine being repeatedly during this time drawn off from the sediment it deposits. During this secondary fermentation the removal of sugar is completed, the albumen is also either precipitated or oxydised, and a slight deposition of tartar continues; whilst more of the alcohol is converted into acetic acid, and, in red wines, much of the colouring

means of which arrangement the temperature is kept as low as 6° C. during the entire summer.

* A compound ether may be considered as a combination of the acid with the alcohol, minus one atom of water. Thus:—

alcohol	C_2H_6O
acetic acid	$C_2H_4O_2$
	$C_4H_{10}O_3$
minus water	H_2O
acetic ether	$C_4H_8O_2$

matter and tannin is thrown down. The formation of compound ethers by the mutual action of the different acids and alcohols present goes on, and at the same time some of the compound ethers of the higher fatty acids at first formed, are gradually decomposed and converted into ethers of the lower acids: as a consequence the wine increases in bouquet. This formation of compound ethers, however, ceases long before all the acids present have been converted into ethers; the necessary conditions for such complete conversion being, that the acids should be dissolved in absolute alcohol, and that the water produced during the formation of the ethers should be removed. The presence of water prevents the complete etherification of the acids, even when mixed with a large excess of alcohol; the greater the proportion of water, the less complete the etherification. After the lapse of from three to six years, according to the nature of the wine and the temperature at which it is kept, this formation of compound ethers will thus arrive at a maximum, beyond which it cannot go except there be some alteration in the amount of alcohol or acid present, when the process will start again, so as to arrive once more at an equilibrium. Professor Berthelot, the celebrated French chemist, has given a formula, by means of which we may calculate what amount of compound ether may be formed in a wine containing a given proportion of alcohol, acid, and water. If, therefore, we possess the means of accurately estimating the amount of compound ethers present in a wine, we obtain thereby a guide to judge to a certain extent of its age. Berthelot himself has given a process for estimating these ethers applicable to certain classes of wines; and the author has, more recently, published a method by means of which the amount of compound ethers in all classes can be estimated.

The latter process also enables us to gain some insight into the nature of the compound ethers present; the complete separation and estimation of the different compound ethers present have, however, still to be accomplished. This may be less a matter of surprise, if it be borne in mind, firstly, that a wine containing, say, 5 different acids, and 5 alcohols (and wine contains often more than that number), may contain 25 different kinds of ethers; and, secondly, that even of such compound ethers as are found in greatest abundance in the wine —namely, malic, tartaric, and acetic ethers—there is rarely more than 1 part present in 2,000 parts; whilst of some there is certainly less than 1 part in 100,000 parts. But, as stated above, a certain amount of insight may nevertheless be obtained.

The acids present in the wine may be conveniently divided into two classes: first, such as are volatile without decom-

position, and may accordingly be separated from the wine by distillation or evaporation; and, secondly, such as cannot be distilled without decomposition. The first consist chiefly of members of the fatty acid series; acetic acid forming by far the greatest proportion. These are generally termed volatile acids; the second, as tartaric and malic acid, are comprised among the fixed acids. If these acids form compound ethers, the ethers of the volatile acids are likewise volatile, and may with care be distilled off from the wine without suffering decomposition: the ethers of the fixed acids cannot be distilled without decomposition, and remain behind in the residue from which the volatile ethers have been driven off.

Both classes of ethers admit thus of separate estimation; in both cases, however, the aggregate amount only, and not the individual members that make it up, is estimated. None of the ethers of the fixed acids possess striking flavour, nor contribute much to the general character of the wine, beyond, perhaps, the neutralisation of part of the free acid effected in their formation. As the wine gets older, however, the amount of non-volatile ethers diminishes, the alcohol they contain being gradually transferred to volatile acids; and in this manner these fixed acids facilitate the formation of the volatile ethers. Most of the volatile ethers, on the other hand, are distinguished by a very powerful and often, particularly when very diluted, extremely agreeable smell; and a great part of the odour and bouquet of the wine is no doubt due to them.

At the end of from five to twelve years, the wine may be considered to have arrived at maturity; that is to say, the slow chemical changes going on have reached the maximum amount that is still beneficial: after this the wine no longer improves by keeping, except to the taste of a few would-be connoisseurs.* Generally speaking, the lighter classes of wine arrive sooner at maturity than stronger and heavier wines. The foregoing sketch refers chiefly to pure natural wines; in strongly fortified wines, all chemical changes are more or less modified, and usually take a longer time for their consummation. Such wines require fifteen or more years to bring them to perfection; such time being, in great measure, necessary to undo and correct the evil done in brandying them originally.

The chemical changes taking place in the wine go on, however, unceasingly in cask or even in bottle, owing chiefly to the oxygen finding its way by endosmosis through the sides of the cask, or even through the cork of the bottle: or through its having been absorbed by the wine in the act of transferring it

* Some, exceptionally rich, natural wines do improve even after twelve years, but the above statement will be found to be true in most cases.

from one cask to another, or in the bottling. Under the influence of this oxydising action the wine gradually deteriorates, more and more alcohol is converted into acetic acid, colouring matter is precipitated, and the different odoriferous compounds, produced at first by the action of oxygen, are now gradually destroyed by it, and the wine perishes slowly but surely. Some wines pass through all these changes in a comparatively short time; others may keep for 100 years or more.

IRON SHIELDS FOR FORTS.

By S. J. MACKIE, Assoc. Inst. C.E.

THE subject of iron shields having been so very prominently brought before the public during the past few months, it may well and properly in its scientific aspect find a place in this popular journal. It has now come to be regarded as essential by the most advanced military countries to employ iron for the defence of the most vital and exposed parts of fortifications, to protect the costly and powerful guns with which such portions are or will be armed. Without going into all the reasons which have rendered the use of iron imperative, we may briefly dwell upon the necessity of keeping out the terrible modern missiles from the works, the quick destruction effected by heavy rifled artillery upon granite and stone walls, and the increasing difficulty of dealing with earthworks of the enormous thickness now required in respect to the increased exposure of the guns and men in the embrasures. It will be seen at a glance that as the opening through which the gun is fired must be wide enough to allow for its training, even a masonry work of the minimum thickness must, by being cut away on the diagonal, be considerably weakened at the very place where the greatest amount of strength would be required.

What becomes a serious defect in a seven feet thick wall, becomes frightful in mounds of from six to nine times that depth. In both cases, therefore, the necessary opening for the use of the gun would be properly closed by an iron shield; the metal admitting at once of both a stronger as well as a thinner defence. An iron wall all round the fort is not essential, nor even desirable, except where a number of guns have to be crowded together within a very restricted area. If not broken into by openings, the simple earthwork would be preferable for the defence for many other reasons than the economic one of cost.

The problem then to be solved in the construction of the iron shield is not a light one. We have to provide in it such

cohesion and resistance over a very restricted area as shall enable that restricted space to receive and endure the concentration of the assaulting fire from the enemy's most powerful guns, and that so effectually that no harm shall come to the gun or to the gunners. We must do this with the least possible amount of material, the least possible depth of structure, and with the greatest economy of expense. A good shield sufficient to resist such guns as our own artillery could not be produced and fitted under 1000*l.*; and there are not less than 300 imperatively called for at this moment for only a few of our most important works. It is evident, therefore, by the problem to be solved, as well as by the circumstances under which it must ever be regarded, that the utmost skill, care, and efficiency of purposeful design is absolutely essential.

There are four main systems of shields or targets at this time prominently before the world: 1. Solid plates, represented at the late Shoeburyness trials by the 15-inch rolled plate of Sir John Brown & Co., of Sheffield, and the 15-inch hammered plate of the Thames Iron Ship-building Company; 2. The laminated, or plate-upon-plate system, and represented by the Gibraltar shield; 3. The plank system, represented by the Plymouth casemate; 4. The compound backing system, represented mainly in one aspect by the Chalmers' target, and in its other, and so far as yet proved the best form, represented by the Millwall shield, designed and constructed by Mr. John Hughes.

In the first place we must thoroughly understand what we have to provide against in making a shield. We have to keep out shot and shell of weights varying from 115 lbs. to 600 lbs. (the largest proportion of our own rifled guns being 250-pounders), all being thrown with terrific energy. These missiles, as used in the British service, are made of chilled metal upon Major Palliser's system, and are intensely hard and of dense rigid molecular constitution. The Palliser shot will split up into the most terrible langridge, which if it passes into the defensive works will carry slaughter all around. Dashed from the face of the target, the splinters fly back in every direction for hundreds of yards; but the metal of the shot will not squash or yield in form, each fragment falls perfectly cold upon the ground with its edges sharp and angular, totally unlike the flattened and distorted portions of common iron or soft steel projectiles, which burn the fingers that attempt to handle them with the heat set up by the violent motion produced by the friction of the intersliding particles in the mass of metal affected by the force of the blow. The Palliser shells have, in consequence of the thickness required to be given to their walls, very small bursting charges, which appear to assist by their explosion at the moment

of impact the passage of the missiles, but are not capable of yielding any greatly increased destructive effects after complete penetration is effected. We can therefore, for simplicity sake, here regard them as only a slightly more penetrative kind of shot.

We have, in the second place, to consider equally what we have to provide for in designing a shield. It is evident, if ever the shield does any duty, that it must meet with injuries, and repairs therefore will be needed. It is also evident that, whether single solid plates, or several plates, or many planks or bars of iron were employed, that they could not be merely stuck in the ground or heaped upon one another; therefore a framework is required to fasten the armour upon and to hold it together, as also to permit of repairs being made after action, or in consequence of decay. Incidentally, also, there is the prospect of strengthening being required to meet the possible advance in the power of ordnance.

Bearing in mind these primary conditions, we have, in the third place, to consider how we can best meet these requirements; and, in doing so, we must further understand the effects of vibration of one plate upon another, the action produced by the shot upon the armour, the strains upon the bolts, the means of dispersion of the striking force, the resistive strength of the metal, and the manner in which it acts and is acted upon, as also the qualities of material best suited to arrest the shot in the shortest possible time with the least possible injury to the shield.

The frame is, then, the first element in the design of these defensive works. For ourselves we shall in this article have been saved much trouble and space by the results of the recent Government trials at Shoebury, which have clearly and decisively shown the mechanical and resistive superiority of the Millwall shield, as well as the superiority of its metal, over all competitors past or present. Of Mr. Hughes it ought to be fairly and proudly said, that he has both taught the world how to make armour plates and how to use them. Moreover, the frames used for all the systems of armour so far tested have been modifications of the plan first proposed many years ago by this gentleman—a self-made man, by nature and experience a consummate iron worker, and a thorough mechanician. We shall therefore take this best example for our type, and we present our readers with its portrait, just as it stood up to be shot at. The reader, however, must bear in mind that this shield was designed to carry out three experiments, and that therefore a shield of this class erected in a fortification would have a perfectly fair smooth face, and not the irregular one in this case, caused by the three different thicknesses of armour-plating

employed for these experimental purposes. It must also be borne in mind that Mr. Hughes' design was far in advance of any other, and that his shield was made and delivered to the Government over two years before it was shot at, and twelve months before the designs of the Gibraltar and Malta shields—the first made for actual service in this country, although Russia, Belgium, and Peru had for some years employed iron in their land defences—were issued by the Royal Engineer Department to contractors. In consequence of the advance made in the power of artillery in this interval, Mr. Hughes was allowed to strengthen his target, before it was brought up to the competition, by the addition of girders of the same depth of metal as had been employed in the strengthening girders of the Gibraltar shield. This addition is necessarily a patch, as it had to be fitted on through the bolt-holes, and in connection with other parts already existing, and planned without any conception of future modification. In designs upon this principle hereafter, a thinner, more homogeneous, and far more elegant structure could be produced at a less cost, and with greater strength of endurance and resistance. The competition with the Gibraltar shield having now been carried out, round for round, the same in range, in character, weight and velocity of projectiles, by the same guns, and the same charges of powder, the comparison of the plate-upon-plate system with the hollow stringer compound backing system is complete. We have then in this frame a very simple structure—a broad sheet of iron, or "inner skin," supported at each side by a triangular strut, secured to suitable base-plates. This skin forms the internal wall of the defensive work, and never ought to be pierced; everything—shot, shell, and langridge—ought to be stopped outside of it, if the shield is to be really a defence. And either a defence, a perfect defence, it must be, or it will be a murderous blunder and a devilish deceit. Palliser shots have never yet been fired in anger, nor has a 9-inch Woolwich gun ever yet lodged these terrible things in fort or ship. Few men—very few men indeed—have seen as yet enough to know even the probable results, and those few must know (although some for selfish reasons will not admit) their deadly destructiveness; but the public at large must no longer rely upon pluck and spirit to make up for mechanical and structural deficiencies. Not that British pluck and spirit would not make men calmly walk up to certain death, or would not keep them at work in the midst of direst horrors, but weapons and their appurtenances that cost from 2,000*l.* to 5,000*l.* apiece can be disabled by a splinter; and an artilleryman, trained by years of practice to hit a two-foot square at a thousand yards away, may be put *hors de combat* by a bit of langridge not bigger than a

marble, or killed outright by a sheared-off bolt-nut. Men and material are alike too costly to be sacrificed, made food for powder, as in days of yore. We cannot now replace such loss. Moreover, in these iron defences there is so slight a margin, that there is practically no medium between perfect security, on the one hand, and that worse than utter uselessness which transforms a comparatively harmless flying shot—that merely hits or misses a solitary mark, or at most knocks over a few isolated men—into a wide-spread shower of fragments, hailing destruction to life, limb, and material within the limit of a hundred yards around. The chief considerations to be regarded in this frame, beyond its duty of securing the armour and holding it up to its work, are the fastening it securely in position, so that it shall not be driven back, moved laterally, or toppled over by the blows of the shot. It is also requisite to provide a slight amount of head cover to protect the guns and defenders against missiles falling from high trajectories, and to prevent the knocking away of the top edge of the shield by direct fire from the attacking batteries. The sole-plate should have, too, a ledge extending beyond the face of the shield, to grip the armour and prevent its buckling. A rim of this nature all round would have a good effect.

We now come to the main defence, the armour-plating. The very thick solid plates are up to this time, through imperfections of manufacture, and unsatisfactory and rude experiments, open to the serious objection of being liable to split across. A plate so split might fall asunder, or its two halves might be driven in bodily by the succeeding fire of the guns; in short, a split plate would no longer be a serviceable defence. It is, however, only just to admit that the solid plates have not in any Government experiment we have seen been as properly supported and set up as they would have been in a permanent fortification; and both in respect to the "Brown's plate" and the "Thames plate"—the latest efforts at 15-inch plates—the rough manner in which they were set up helped materially the rapid consummation of their disrupture. Nevertheless, the iron in both cases did not come up in its working to the quality of the best 5-, 6-, and 8-inch plates; and when we reflect upon the vast masses to be properly heated to welding heat, the increased number of processes to be gone through, the enormous weights to be lifted and moved about in a limited time, and the variety of accidents which can happen to an armour-plate in the operations of the furnace, the rolling-mill, or the forge, all multiplied in liability as the thickness and weight of the plate increases, and, finally, that the machinery has not been specially constructed for such grand labours, we should not be surprised at deficiencies, but ought rather to leniently judge, by inference from what is done,

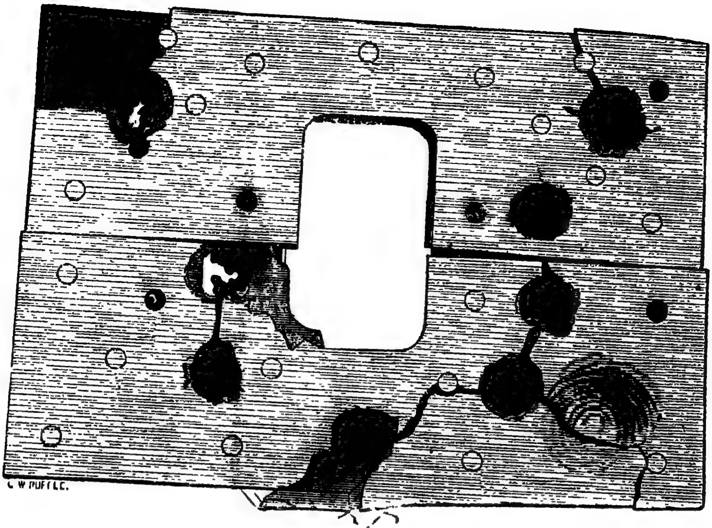
what it is possible to accomplish. For whether we shall ever see used the thickest plates unbacked or not, it is certain that thick plates will be required as face plates for all the composite targets, to take the main work out of the shot before it gets at the rear plates, if iron be put upon iron, or into the wood, or compound backing, whichever may be employed. Nothing has stopped a shot so effectually, or within less distance, or less time, than a solid plate of rolled iron; and nothing will stop it quicker, or with less penetration, unless it be hardened steel, or chilled iron, both rigid materials, and consequently brittle. Experiments have all, so far, shown hard steel, chilled and cast iron, alike to be untrustworthy, and unsuitable materials. They are shattered by the shot like looking-glasses. Now a starred plate is a greatly damaged one; every fresh blow, even if the shot does not penetrate, opens by vibration and buckle the fissures, and continues their courses. Portions are thus flaked away, and a ruin full of vulnerable spaces is presented to the enemy's view. The inability to endure this starring is the fatal defect of the plank system, and one which is insuperable in it. Suppose an ordinary 8-inch plate, 4 feet 6 inches wide, to be pierced and starred by a 9-inch shot. There would be, as a general rule (for which there is an explicable reason), four rays or fissures passing away at right angles to each other from the shot-hole. These fissures are very seldom less in length than the diameter of the shot. Thus, with a 9-inch shot, from one end of one fissure to the termination of the opposite one would be 27 inches, on each side of which there would remain 13½ inches of the plate uninjured, and quite sufficient to hold the whole plate together. But if the same fissure were made—as the same shot would produce—in a plank of the same thickness, but only 16½ inches broad, the plank would be cracked completely asunder. If the plank were made of more tensile iron it would be only very slightly better off, for the more the plank bent the more the back of the plank would be torn apart, and ultimately a complete split would happen from a totally different cause. In the plate-upon-plate system, in which thick laminæ of 5 or 6 inches of iron are put direct upon each other, the vibration and shearing action is immense, and the bolt heads and nuts are sure to fly unless extraordinary precautions are taken. Moreover, this system is open to the very serious mechanical defect of presenting very weak spots at the cross or intersecting joints, when the plates of the different laminæ are placed alternately horizontally and vertically. Thus in the Gibraltar shield all the plates were of the same dimensions, the face plates being laid horizontally and the rear ones vertically. The joints therefore intersected, and a shell fired at this point went clean through, clearing out a great

triangular gash, extending up to the side of the port-hole. Both the plate-upon-plate and the plank systems present, then, structural deficiencies; and there can be, therefore, no excuses but economy, or facility of repairing, or of increasing the strength of the defence, for their adoption. All these reasons apply with greater force to the compound system of Mr. Hughes, as we shall hereafter show. It is with his system, then, that we shall now occupy our present thoughts. Timber backing *per se* is next to useless as a directly resisting material; but wood is highly useful in absorbing and deadening vibration. Hence a semi-elastic backing of wood and metal starts with a valuable inherent property. Every mechanic knows the value of a box-girder; how the strains brought upon it in every direction are taken up equably by every portion of the hollow beam, and equally divided between parts in compression and parts in tension. Now, when Mr. Hughes' hollow rails, or, as he calls them, stringers, are riveted up to the skin of the frame, anyone can see at a glance what a magnificent row of box-girders he has to take up and distribute the strains locally brought within such narrow limits upon the face-plate of the shield. These stringers infilled, and filled between, with strong teak constitute a semi-elastic cushion of enormous strength, and the greatest capacity for the widest distribution of the forces of blows or strains. This cushion can be supported by another in which the stringers cross each other at right angles. Instead of a weakness arising, strength accrues directly, for not only do the vertical stringers back up the horizontal at their intersections, but there is at every such place twice the amount of depth of metal to be cut away, by a shot striking on those crossings, than there is upon the other best supported parts of the front plate. The holes cut in a plate for the bolts are always leading points of fracture for the shot, and the distention of the plate by shot is one of the main causes of the shearing of the bolts. Both these evils are avoided by the hollow stringer backing, because the bolts can pass between the stringers, and can screw up the face-plates direct as it were to the skin-plate, gripping in the semi-elastic backing as a pad between them. So far then, mechanically, every advantage is on the side of the hollow stringers as a preservative backing for the defensive structure.

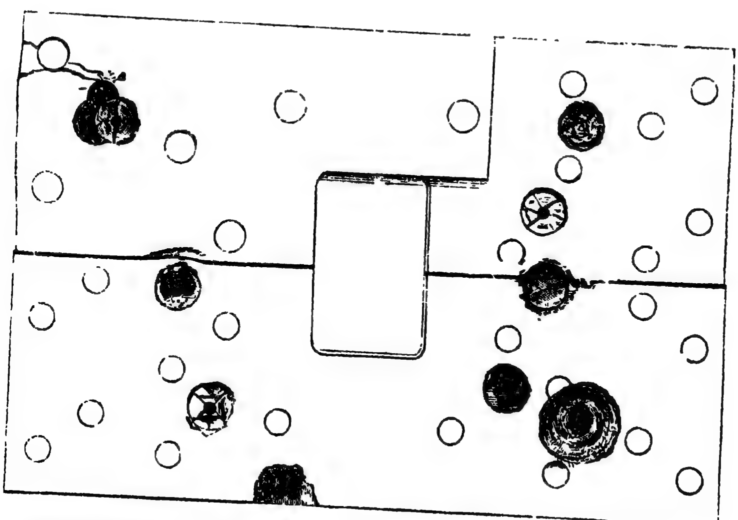
What as to its resistance to penetration? To any but a mechanical expert this backing would look like a sieve or a net full of meshes, through which the shot could squeeze its way. The 9-inch shot has tried that, but the hollow stringers have gripped it hard and fast, would not let it go by; and then the 10-inch shot (400-pounder) has come up to help it—hit the pioneer, as it stuck, direct on the rear, drove it in an inch or two further,

but could not drive it through: the hollow stringers held their grip too well. They skidded or "braked" the shot, just as an iron strap pressed down by a lever stops the running of the wheel of a crane or a machine. Only the hollow stringers riveted up along the whole length of their flanges held a good deal tighter. Here, then, is a new element of resistance in direct proportion to the depth of the stringer, and the depth of the stringer directly increases the support of the armour and the general strength of the shield. In solid plates one would seem to have the full strength of the metal, presuming the manufacture to be in all cases equally good; and we have always been led by the Government reports to regard the resistive capacity of armour-plates as increasing in the proportion of the squares of the thickness. Thus, taking a 1-inch plate as the unit, we should from nine 1-inch plates obtain a combined resistive power of 9; but from a solid 9-inch plate we should have a resistance of 81, whatever the value of that amount might be, and which of course would vary with the quality of the iron or material employed. Certain special experiments have been made for, and referred to, in connection with the plate-upon-plate system, which should cause some slight modification of this rule to be acknowledged when combinations of very thick plates are employed; but, nevertheless, it may be still adhered to in ordinary and not actually exact considerations, the difference being a moderate percentage, and not a vital or very largely important element. This view would incline one towards solid plates properly backed, and induce to the encouragement of their more perfect, although more costly, manufacture. Seeing the great power of the hollow stringer, one is tempted, however, to ask if more strength can be got out of the material by a judicious disposition of it in layers than exists in the solid plate. Let the following experiment reply. It was made with a falling weight, for the purpose of testing the resistance of the hollow stringer riveted to two 1-inch plates having a bearing of eighteen inches, as against pieces of 4-inch, 5-inch, and 6-inch plates, of the same width as the hollow stringer, and similarly supported: the tables on page 373 show the results.

Money is the sinew of war, as of all other terrestrial operations; and the man who economises his little is better off, and produces better results, than the thoughtless spendthrift. Even rich nations cannot afford 40*l.* a ton for an expensive material in an expensive form, if it can get a cheaper material in a more useful form for 18*l.* The rolling of these hollow stringers is a cheap operation; they are light and manageable, and can consequently be most rapidly turned out—no re-heatings are required, no planings, no risks, no failures, no constant tendency



FRONT OF GIBRALTAR SHIELD AFTER THE TEN ROUNDS OF SHOT AND SHELL HAD BEEN FIRED AGAINST IT.



FRONT OF MILLWALL SHIELD, AFTER THE TEN ROUNDS OF SHOT AND SHELL HAD BEEN FIRED AGAINST IT.

Description	Weight of Ram	Fall	Number of Blows	Permanent Deflection
	lbs.	Feet		Inches
Hollow Stringer 7″ deep, 9″ wide	1512	33	5	$\frac{5}{8}$
4″ Armour-plate, 9″ wide	1512	33	5	2
5″ Armour-plate, 9″ wide	1512	33	5	$1\frac{1}{4}$
6″ Armour-plate, 9″ wide	1512	33	5	$\frac{5}{8}$

TABLE OF EFFECTS OF EACH CONSECUTIVE BLOW—

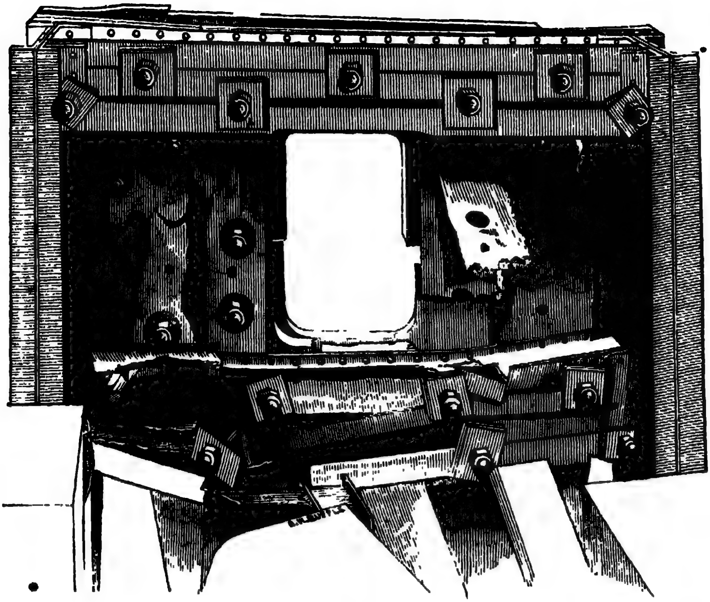
Blows	Hollow Stringer	4-inch Plate	5-inch Plate	6-inch Plate
	Inches	Inches	Inches	Inches
No. 1	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{1}{8}$
No. 2	$\frac{1}{4}$	$\frac{15}{16}$	$\frac{9}{16}$ bare	$\frac{1}{4}$
No. 3	$\frac{3}{8}$	$1\frac{1}{4}$	$\frac{13}{16}$	$\frac{3}{8}$
No. 4	$\frac{9}{16}$	$1\frac{3}{4}$	$1\frac{1}{16}$	$\frac{1}{2}$ full
No. 5	$\frac{5}{8}$	2	$1\frac{1}{4}$	$\frac{5}{8}$

to costly accidents, the expense of which has to be put on to the successful results. There is no restriction, therefore, to their employment in any mass of defensive work the earth will sustain—or, as we think, the water will float. All that has been urged against this system, with any more than the most shallow opposition, is an objection against its depth as interfering with a larger training of our heavy guns beyond an angle of 65°. How many of the guns now in position in earthworks and masonry forts train more than this? Only *en barbette* is the range greater, and then the gun is totally exposed above the parapet. But when we come, as we do in iron structures, from fifteen feet of masonry and sixty feet of earthwork, to fifteen inches of solid armour and thirty inches of composite shield, front plate and compound backing both included, are we to quibble over a few inches of wall in our shield, or a degree or two in the training of our gun through a porthole of the most diminished aperture—an opening diminished also from dimensions in feet to dimensions in inches? Are we, too, to overlook the necessity of time as an element of resistance? One of the reasons why a solid 15-inch plate so rapidly breaks up under pounding may be because there is no backing to absorb vibration, and no sufficient time for the distribution of any considerable portion of

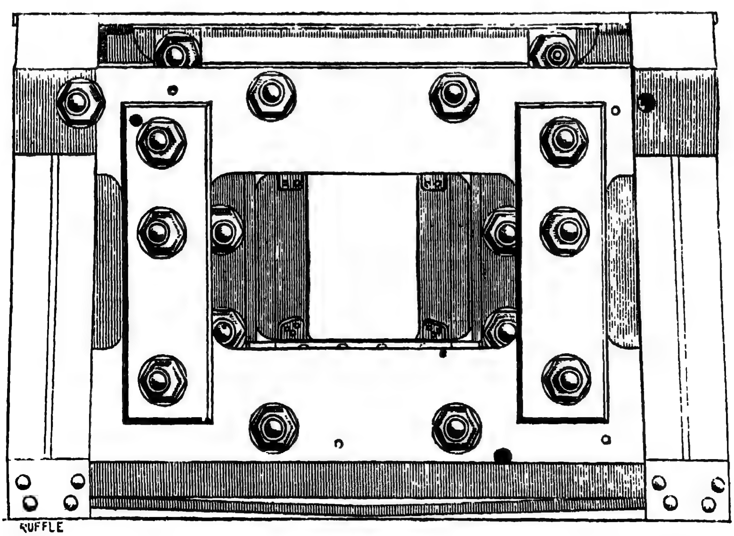
the force of the blow laterally over the plate in the form of tension. Tension needs time as a most essential element; time as an element is correlative with depth of structure. In the notion of extreme of thinness of iron wall we seem to be chasing a shadow in a wrong direction. It is friction which arrests the shot; friction is the work done. A shot passing through the air flies a long way because the friction is small. What it takes thousands of yards to do in the atmosphere, is done in a few hundred at most in the water—would be done in a few feet by lead—is done in a few inches by iron. What seems, therefore, requisite for an armour-plate is a moderately yielding iron that will squash out as the shot enters with the greatest amount of molecular friction. This ideal iron has been actually produced in the shield and casemate manufactured at the Millwall works. The shots squash holes in the face-plates, and do not star or split them. From the ten shots fired against the front plate of the Gibraltar shield, in which Cammells, of Sheffield, put first-rate iron, of the kind hitherto in general favour, there were no fewer than thirteen severe fissures, besides large detached pieces; from ten shots in the Plymouth fort there were thirty-two bad cracks, besides pieces similarly broken off, in excellent plates of hard quality made to order by Sir John Brown. In the face of the Millwall shield there was not, after the ten rounds, a single fissure of any account, and except for the pittings the shield was all but as good for the defence as before the first shot was fired against it. The inner skin of the shield was absolutely perfect; a few rivets were jarred off, but with far too little force to inflict a wound even at close quarters, some simply dropping down on ledges beneath; a few bolt nuts were loosened through the squashing of the india-rubber packing. The only scars visible at the rear of the defence were the jagged edge of the front lintel of the porthole, where the 450-pounder Rodman struck it, at the fourteenth round, as it were right in the eye, and the scoops made by the langridge of that shot as it glanced downward upon the inside edge of the port-cill. We have given the faces of the rival shields after the actions; we now present the state of their backs, leaving judgment of the efficacy of the rival systems to all beholders.

Since these pages were in type, the most powerful gun in the world—our rifled 600-pounder—has been brought against Mr. Hughes' admirable shield, which has most successfully resisted it at the very close quarters of only 70 yards range, and fired with 74½ lbs. charge of powder.

One paragraph only in conclusion. We have spoken of the attacks against the shields solely as made by British projectiles. No other country possesses shot or guns of the like tremendous penetrative power. The heaviest guns that could at present be



BACK OF GIBRALTAR SHIELD AFTER THE TEN ROUNDS OF SHOT AND SHELL HAD BEEN FIRED AGAINST IT.



BACK OF MILLWALL SHIELD AFTER THE TEN ROUNDS OF SHOT AND SHELL HAD BEEN FIRED AGAINST IT.

brought against our armaments are the American and the Prussian; but foreign countries will probably be soon supplied by British manufacturers, and weapons of our classes may be brought against our works in any future war, and therefore we have a right to think of what purchase or capture might do. In keeping out the most powerful missiles we are erring—if it be an error—upon the safe side.

THE AIR OR SWIMMING BLADDER OF FISHES.

By REV. W. HOUGHTON, M.A., F.L.S.

EVERY fisherman is familiar with some of the forms of the organ known as the air-bladder found in many kinds of fish, whether tenants of our ponds and rivers or of the sea. Sometimes he may remember being startled to hear a gurgling sound proceed from the trout from whose mouth he is extricating the fly: this sound is occasioned by the air being forcibly pressed by the hand out of the air-bladder through the œsophageal orifice. The subject of the swim-bladder of fishes is one of considerable interest to the naturalist; let us take a short survey of it.

The organ in question is found in most osseous fishes*; it extends along the back of the abdomen, between the kidneys and the intestinal canal. The forms of this air-reservoir are various. Sometimes, as in the perch, it is a simple elongated cylinder closed at both ends; sometimes, as in the carp, tench, roach, and other *Cyprinidæ*, the organ is divided crosswise into two portions, by a deep constriction with a minute orifice leading from the one portion to the other; or these two compartments may have no communication with each other, as in *Bagrus filamentosus* and a species of *Gymnotus*. Sometimes, as in the genera *Arius*, *Polypterus*, and *Lepidosiren*, this organ is divided lengthwise into two compartments; or it may be bifurcate; or divided into "four longitudinally succeeding portions," as in the genus *Pangasius*, one of the *Siluridæ*. The sapphirine gurnard (*Trigla trirundo*) has a swim-bladder divided longitudinally into three lobes, of which the middle one is the largest; in other gurnards it is bilobed. "Sometimes the air-bladder is divided partially, both lengthwise and crosswise, as in *Cobitis fossilis*, *Auchenipterus furcatus*, and some species of *Pimelodus*." In *Corvina hispinosa* the air-bladder gives out two somewhat slender processes on each side, one extending upwards, the other in a contrary direction. The

* It is also found in the Cartilaginous Sturgeon.

maigre (*Sciæna aquila*) presents an air-bladder with a fringe all around its edge, which consists of numerous ramified pneumatic cæca. In *Gadus Navavaga*, Professor Owen tells us, "the lateral productions expand and line corresponding expansions or excavations of the abdominal parapophyses, thus foreshadowing the pneumatic bones of birds. In *Kurtus* the air-bladder is encircled by expanded ribs, curving and meeting below it." In Amia the air-bladder exhibits such a cellular structure that Cuvier could compare it to nothing else than the lung of a reptile; this cellular subdivision is still more strikingly shown in the Lepidosiren or mud-fish. Thus we have, as it were, a complete series of modifications, from the simple elongated cylinder of the perch or herring, through the various forms exhibiting cæcal processes, up to the completed lung-like structure of the air-bladder of the Lepidosiren. The air-bladder consists of two membranes, an external tendinous membrane of a silvery colour, and an internal mucous membrane lined with flat or "plaster epithelium," and supplied with blood-vessels which either divide into fine branches, in a fan-like form, or else form what have been termed *retia mirabilia* at particular points. These *retia mirabilia*, or vaso-ganglions, may readily be seen in the air-bladder of an eel, in the form of red glandular-like bodies of an oval shape. In some fishes a duct leads from the air-bladder to the stomach or the œsophagus: this is known by the name of the *ductus pneumaticus*. It is a simple membranous tube, presenting, however, much diversity in length and diameter, and also in its point of communication with the digestive apparatus. "In the herring the *ductus pneumaticus* is produced from the posterior attenuated end of the cardiac division of the stomach, and opens into the fusiform air-bladder at the junction of the middle and posterior thirds of that organ. The long narrow and flexuous *ductus pneumaticus* is continued from the fore part of the posterior division of the air-bladder in the Cyprinoids, and opens into the dorsal part of the œsophagus; the short, straight, and wide ductus pneumaticus in the Lepidosteus opens also into the dorsal part of the œsophagus, the orifice being served by a sphincter. In the *Erythrinus* the air-duct communicates with the side of the œsophagus; in *Polypterus*, as in *Lepidosiren*, with the under or ventral part of the beginning of the œsophagus."* The contents of the air-bladder of fishes have been analysed by Humboldt, Biot, and others, and, strange to say, remarkable differences are stated to exist, according as the fish are fresh-water or marine. The air consists of a mixture of nitrogen and oxygen, with traces of carbonic acid gas: in fresh-water fishes the largest

* "Comparative Anatomy and Physiology of Vertebrates," vol. i.

percentage of nitrogen occurs; in salt-water fishes oxygen is said to occur in the largest proportion. Some, I believe, have maintained that the air of the swim-bladder of carps consists of pure nitrogen. Humboldt, who experimented on the electric eel (*Gymnotus electricus*), found the gas of its air-bladder to consist of 96° of nitrogen and 4° of oxygen. Biot, on the other hand, experimenting on some deep-sea Mediterranean fishes, discovered 87° of oxygen, the rest nitrogen, with a trace of carbonic acid. This, if an undoubted fact, is certainly a singular anomaly, and I confess I share, with the late Dr. Davy, some doubt as to the accuracy of the experiments. "That the same organ should secrete two gases so very different in their nature, appears anomalous, and deserving of further enquiry. Indeed, does not the entire subject need more minute enquiry? At present the facts relating to it are few, and seem far from adequate to allow of very satisfactory conclusions being drawn as to the use of the bladder and its secretion in the animal economy; except of a mechanical kind, as effecting the specific gravity of the fish. Were the gas uniformly of one kind, were it constantly azote, it might be easy to assign it a plausible end, the function of the air-bladder might be inferred to be auxiliary to that of the kidneys. The secretion of oxygen is the anomalous fact, so contrary is it to the ordinary course of changes in living animals, in which the general tendency is to the consumption of oxygen—*à priori*, one might almost as much expect oxygen to be exhaled from the lungs, in respiration, as to be separated from the blood by secretion by the air-bladder; and had we not the authority of so accurate an observer as M. Biot, we might be led to suspect that the statement of its being so was founded on error." †

How does the air gain admittance to the air-bladder? In the case of those fish whose air-bladders possess no ductus pneumaticus, it is clear that the gas must be secreted by the inner membrane of the bladder from the blood; but in fishes which are provided with a ductus pneumaticus, so as to lead to a communication with the œsophagus, the air may in a great measure be derived from the atmosphere, as in the case of trout when they rise at a fly. This opinion was held by Rathke and Dr. Davy. Further experiments on this interesting subject are very desirable, for we seem to know at present very little positively about it. We have seen how varied is the form of the air-bladder in those fishes which possess one; let us now notice its presence or absence in the different orders. In the *Cirrostomi* and *Cyclostomi*, represented by the British lancelot (*Branchiostoma*) and lamprey (*Petromyzon*) respectively, the

† "Physiological Researches," p. 271.

air-bladder is entirely absent; in the *Malacopteri* we meet with fish possessing both a swim-bladder and an air-duct (*ductus pneumaticus*); the *Anacanthini* exhibit in several instances an air-bladder, but no ductus pneumaticus; in the *Acanthopteri* we meet with an air-bladder but no duct; the same is the case with the *Plectognathi* and the *Lophobranchii*; the *Ganoidei* show, in some of the genera of the order, an approximation to a lung-like structure of the air-bladder, which is often cellular and provided with an air-duct. The *Holocephali* have no swim-bladder, neither have the *Plagiostomi*. The *Protopteri*, to which the Lepidosiren belongs, possess a double air-bladder, very cellular and lung-like, with air-duct, glottis, and pulmonary vein.

With regard, however, to the existence of this organ in the different orders, it must be borne in mind that it is occasionally absent in fishes belonging to different genera, and sometimes even in fishes exhibiting merely specific differences. We are thus, naturally enough, driven to the question of *cui bono*? what are the functions of the swim-bladder and air-duct when present? Are they such important organs as by some people they are said to be? What does their presence indicate, and will it serve to throw a gleam of light on that most interesting of all riddles, the origin of species? Paley considers that "the air-bladder of a fish affords a plain and direct instance not only of contrivance, but strictly of that species of contrivance which we denominate mechanical. It is a philosophical apparatus in the body of the animal." This philosophical apparatus is thus described by Roget in one of the "Bridgewater Treatises:" "Independently of these instruments of progression (tail and fins), most fishes are provided with internal means of changing their situation in the water.

"The structure by which this effect is accomplished is one of the most remarkable instances that is met with of an express contrivance for a specific purpose, and of the employment of an agency of a class different from that of the mechanical powers usually resorted to for effecting the same object. When distended with air it renders the whole fish specifically lighter than the surrounding water; and the fish is thus buoyed up and remains at the surface without an effort of its own. On compressing the bladder by the action of the surrounding muscles the included air is compressed, the specific gravity of the whole body is increased, and the fish sinks to the bottom. On relaxing the same muscles the air recovers its former dimension, and the fish is again rendered buoyant. Can there be any stronger evidence than the placing of this hydrostatic apparatus, acting upon philosophical principles, in the interior of the organi-

sation for a purpose so definite and unequivocal?" * Cuvier says, the "most obvious use of the swim-bladder is to keep the animal in equilibrium with the water, or to increase or reduce its relative weight, and thereby cause it to ascend or sink in proportion as that organ is dilated or compressed. For this purpose the fish contracts the ribs or allows them to expand. Certain we are, that when the air-bladder is burst, the animal remains at the bottom, turns up the belly, and becomes deficient in the powers of motion. A curious phenomenon is observed in fishes caught with hook and line at great depths and drawn up suddenly; for the air contained in their swim-bladder expands, as they are ascending, more rapidly than they can counteract by compression, and either it bursts and the abdomen becomes inflated, or by expanding forces the œsophagus and stomach out at the mouth." Cuvier maintained that there is no sufficient foundation for assuming that the swim-bladder offers any analogy to lungs. Professor Rymer Jones, in speaking of this organ, remarks—"In connection with the locomotive organs we must here notice one of the most elegant contrivances met with in the whole range of animated nature, by which the generality of fishes are enabled to ascend towards the surface or to sink to any required depth without exertion." The general function of the swim-bladder, there can be little doubt, is a mechanical one; nevertheless, it does not seem to me that this organ is of such importance, and such an elegant contrivance, as has been so repeatedly affirmed. For how is it, we may fairly ask, that in different genera of fishes of precisely similar habits, some have an air-bladder, others have not? We can understand why it should be absent in the *Pleuronectidæ*, whose habits confine them to the bottom of the water, or in the angler with similar habits; but when we find that one surface-swimming mackerel has a swim-bladder and another species of precisely similar habits is devoid of one, it is obvious, notwithstanding the general function of the organ when present, that it is by no means an essential adjunct to swimming. Of the two sun-fish (*Orthagoriscus*) which occur in our own seas, one has a swim-bladder, the other none at all. Many of the *Siluridæ* possess a large and sometimes complex swim-bladder, but genera occur in which there is no swim-bladder at all. So, again, fish that, for the most part, keep to the bottom are devoid of this organ; but in the mud-loving eel we meet with swim-bladder and pneumatic duct. Experiments, too, if I am not mistaken, have been made according to which, after the puncture of the bladder and the severing of the muscles which act upon it, and even after its complete removal, the fishes have

* "Animal and Vegetable Physiology," vol. i. page 429.

been able to rise to the surface or descend with perfect ease.* According to Professor Kner the form and size of the swim-bladder, its position and development of vesicular glands, not only differ in the various genera and species, but, curiously enough, they vary in one and the same species of fishes of the family *Murænidæ*. Professor Owen has some interesting remarks on the absence of the air-bladder in the surface-swimming sharks:—"Though the air-bladder serves it also enslaves. It opposes, for example, those fishes that possess it in their endeavours to turn on one side, and it demands a constant action of the balancing fins to prevent that complete upsetting of the body which it occasions from the weight of the superimposed vertebral column and muscles when life and action are extinct. The sharks require, by the position of their mouth and in their common pursuit of living prey, freedom in turning and great variety as well as power of locomotion; if they are not aided by a swim-bladder, neither are their muscular actions impeded by one; whilst their swimming organs require that degree of development and force which suffices for all the evolutions they are called upon to perform." But it would appear that there are exceptions to the general rule of the absence of a swim-bladder amongst the *Selachians* (sharks and rays), for, according to the investigations of Micklucho-Maclay, certain selachians are possessed of a rudimentary air-bladder: is this rudimentary organ the remnant, as it were, of a swim-bladder that once existed in a fully developed form in selachians of some remote age, or must we regard it as a new and independent growth? On this question a few remarks will be made by-and-by. Undoubtedly, the most interesting point for consideration is that one which relates to the question whether or not the swim-bladder of fishes is the homologue of the lungs of air-breathing vertebrates. Functionally in all fish, with, I believe, the exception of the *Protopteri*—represented by the two species of Lepidosiren, one belonging to the American, the other to the African fauna—the air-bladder has no relationship with a lung. Its function is generally a mechanical one, of no great importance, however, and occasionally, as in the carp, it serves to intensify sounds in relation to the sense of hearing.

There can, however, be no doubt that, "under all its diversities of structure and function, the homology of the swim-bladder with the lungs is clearly traceable." True, there is nothing at all in the simple cylindrical, closed air-bladder of a perch to remind one of the cellular structure of the lung of an

* Since the above was written I have found that the experiments are recorded in the "Annales des Sciences Naturelles" for 1866. The paper (Du rôle de la Vessie natatoire) is by M. Édouard Gouriet, and is very interesting.

Amphibian, but, as we have seen, there are numerous gradations, leading by various transitions from a single cavity up to a highly complex cellular organ, which both in structure and function is indisputably a lung. The fishes which most closely resemble the amphibians belong to the orders *Ganoidei* and *Protopteri*. Now, in the first of these orders we find a swim-bladder, often cellular, as well as an air-duct. The curious bony pikes of S. America (*Lepidosteus*), remarkable for the hard bone-like scales with which they are covered, and the allied genus *Polypterus* of some of the African rivers, belong to this order. Lepidosteus has an undivided air-bladder with a wide pneumatic duct; Polypterus possesses a double air-bladder and a pneumatic duct communicating with the œsophagus. If we turn to the *Protopteri*, we shall find in the Lepidosiren the transitions completed, for here we find a double lung-like air-bladder with air-duct, glottis, and pulmonary vein—and this respiratory apparatus, be it remembered, is at certain periods functionally identical with the lungs of air-breathing vertebrates; for the Lepidosiren, after the rains have ceased to flood the river Gambia, finds itself left behind in the mud of the retreating waters; the scorching rays of a tropical sun compel the fish to burrow into the mud, in which it forms a kind of cocoon of hard-baked clay. How is the fish to live in this changed locality? As an inhabitant of the water the respiration was effected by means of its gills alone, as in ordinary fishes; but how is the circulation to be maintained now it is a terrestrial animal? Professor Owen tells us in distinct terms:—"Whatever amount of respiration was requisite to maintain life during the dry months is effected in the pulmonary air-bladders; its short and wide duct or trachea, the œsophageal orifice of which is kept open by a laryngeal cartilage, introduces the air directly into the bladders; the blood transmitted through the branchial arches to the pulmonary arteries is distributed by their ramifications over the cellular surface of the air-bladders, and is returned arterialised by the pulmonary veins. A mixed venous and arterial blood is thence distributed to the system and again to the air-bladders. When the Lepidosiren resumes its true position as a fish, the branchial circulation is vigorously resumed," &c. In the Lepidosiren, then, we have an instance of an animal which is a fish at certain periods of its existence and an amphibian at others; and, as it seems to me, we have in the Lepidosiren a striking illustration of the transition of an organ, originally constructed for one purpose, into one for a wholly different purpose. As Mr. Darwin has said, "All physiologists admit that the swim-bladder is homologous, or ideally similar in position and structure, with the lungs of the higher vertebrate animals;

hence there seems to me to be no great difficulty in believing that natural selection has actually converted a swim-bladder into a lung or organ used exclusively for respiration."* It surely is quite conceivable that under changed conditions, acting for a lengthened period, the Salamandroid Lepidosiren—which some naturalists of note still maintain to be more allied to amphibia than to fish—might gradually convert all its ichthycic characters into amphibian ones, just as I believe it has converted not only the swim-bladder and pneumatic duct into an air-breathing lung, trachea, and glottis, but also two pairs of the gills of the branchial arches into vascular channels, in order that it should be able to maintain a slow circulation, as a terrestrial animal, while encased in its cocoon of mud. I see, moreover, nothing improbable in the supposition that in the Lepidosiren we have a living witness of a fish in a transition stage towards becoming, under favourable conditions, a true amphibian; and I can believe that amphibia are altered forms of fish, to which, in some cases, they bear a considerable resemblance; and I further think it not improbable that one of the steps in the transition—and a most interesting and important step it is—is made by the gradual conversion of the swim-bladder and pneumatic duct into a lung and trachea. Why some fish have a swim-bladder, and others of similar habits have none, can, I believe, be only accounted for by supposing, with Darwin, the absolute independence of new and old structures. So that cases may arise in which a swim-bladder and air-duct may become developed in fishes in which at present they are altogether absent; for Kner has told us that these organs vary considerably even in fishes of the same species, and another naturalist has discovered a rudimentary swim-bladder in some of the Selachiæ. I am not aware that anything is known of the embryology and development of either species of Lepidosiren. A knowledge of the embryology would no doubt throw considerable light on the question of the position of this salamandroid in the animal kingdom; it would show us not only its relation to existing animals, but also its relations to extinct types. Its early embryology would probably reveal to us that at one period of its existence it has no trace of amphibian characters, that the cellular lung and trachea, with the subsequent persistent vascular canals, are not developed in the animal's early stage. Let us hope that some enterprising naturalist will ere long succeed in acquiring a knowledge of the development of the Salamandroid Protopteri.

* "Origin of Species."

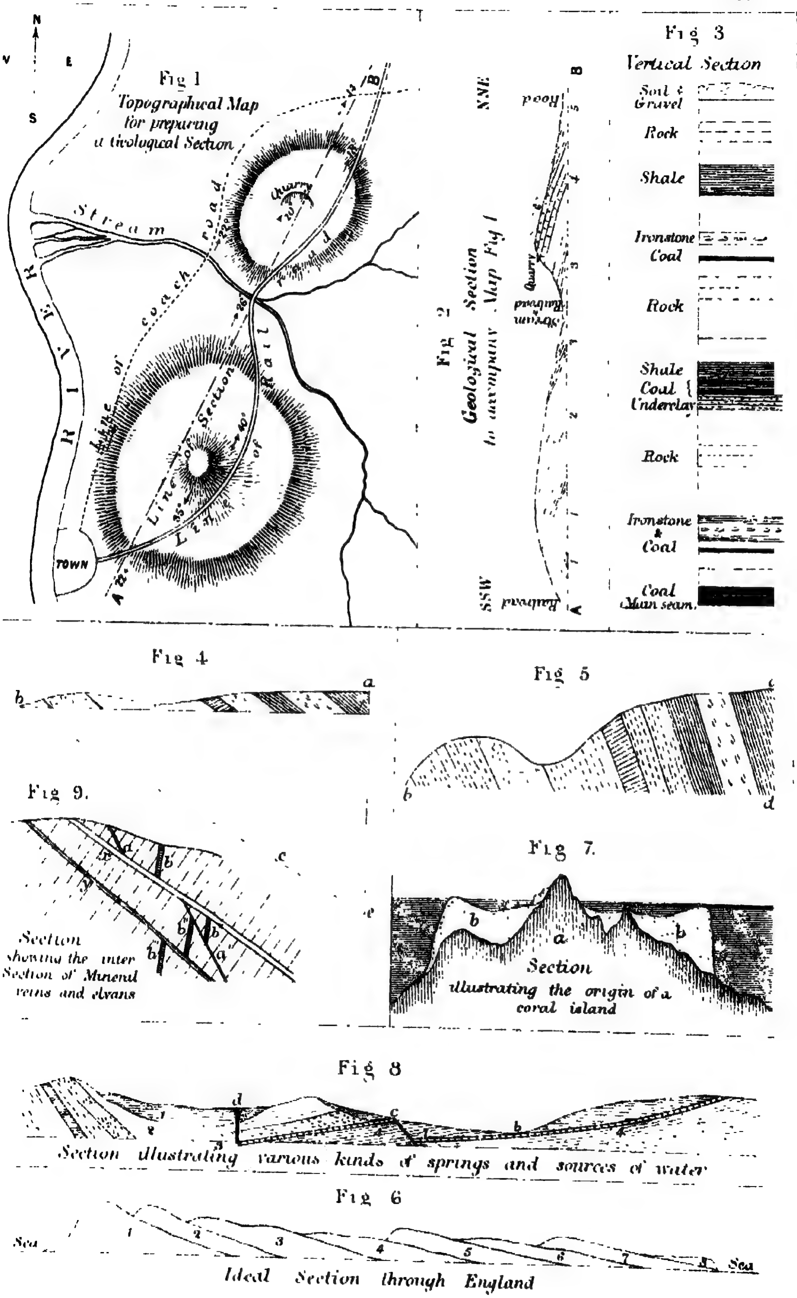
HOW TO MAKE A GEOLOGICAL SECTION.

By Professor D. T. Ansted, M.A., F.R.S., For. Sec. G. S.

SOME of our readers may perhaps wonder what can be said on a subject so simple as this; others may think time thrown away in reading an article that professes to teach a lesson in practical geology best learnt in the field. However this may be, there is much worth recording even in so simple a matter in field geology as the making of a section, and much that may be taught by description. Let us see how sections are made, what they suggest or teach, what varieties there are, and what are the faults and mistakes sometimes made in making use of such representations of nature.

It is impossible to take a step in geology without recognising the great facts of stratification and disturbance of stratification. That almost all deposited rocks are stratified, or, in other words, are placed in successive layers or strata one above another, is a great fact in nature that is recognised in every quarry and every cliff. But it is equally certain, that, whenever we see stratified rocks, they have been lifted up to a considerable height above the bottom of the water where they were originally deposited. This change of position, due to mechanical elevation, has produced in most cases either a tilting of the strata, or a fracture or dislocation of some of them—in some cases both these results. It is of course possible that a very large tract of country should be upheaved at once, so that the greater part of the strata should remain nearly horizontal. But this apparent horizontality may also be the result of several movements of upheaval.

Shaft sections of mines or quarries, road or railway cuttings, cliffs, river banks, or even ditches, often afford sections illustrating the arrangement of the strata. Such sections, however, are not strictly geological sections. They enable the practical geologist to take observations from which he can learn the real dip and strike of the strata, and their thickness; and they become geological sections when they lay bare the order of stratification in a recognisable and instructive manner for a sufficient distance, and are nearly at right angles to the strike of



GEOLOGICAL SECTIONS

the beds. In other cases they only afford materials from which geological sections may be constructed. Simple as they seem, the reduction of such observations to a continued section involves some knowledge of mathematics as well as of geology, and many careful observations made over a great extent of country. Sections do not indeed always represent a long distance. It depends on the purpose for which they are taken whether they express the conditions of stratification for a few yards or hundreds of yards, or whether they refer to distances of miles or even hundreds of miles.

Geological sections are the results of minute observation on the position of strata, and combined with geological maps they lay bare the structure of a country. They are in an important sense the language of geology, and they are no less valuable in practical geology, where they determine important questions in engineering, than in the more popular and elementary part of the science, where they help the student to understand the great facts of the superposition and disturbance of strata.

The first point to be determined in preparing a geological section in a given district is to find the dip and strike of the strata generally over the whole district. The strike of the strata is direction of a horizontal line on an exposed natural face of rock. It is best obtained by the assistance of a spirit level. A long straight staff laid on the exposed surface of the rock is often convenient to obtain a satisfactory idea of the real plane of stratification, and the spirit level being placed on this staff may be turned round with it till it shows a level. The compass bearing of the direction thus obtained is the strike of the beds. The inclination downwards of a line at right angles to the strike, measured by a small quadrant attached to the spirit level, will give the *dip* of the bed, or the angle it makes with the horizon. It is not necessary that observations of this kind should be made with minute accuracy, but they must be repeated frequently wherever there is an opportunity, the position of the place of observation being noted down (on as good a local map as can be obtained) by a small arrow pointing in the direction of the dip and marked with the number of degrees. It must not be assumed that the dip is the same at places some little distance asunder merely because the eye detects no change; it is, on the contrary, very seldom that there the dip is absolutely constant, and small changes of dip sometimes indicate faults and disturbances of serious import. The dip is rarely identical even in different parts of the same quarry.

The diagram (fig. 1) in the annexed Plate illustrates the case just described. By a few observations in the field, it is found that the general strike of the strata is nearly NW. and SE., and that in the southern part of the tract represented (near the

town) the inclination of the beds is towards the SW. or in the direction of the town, the amount of the inclination being at first 22°. At a short distance the dip is found to increase to 35° in the same direction. A little farther on, however, the amount of the dip being nearly the same (40°), the direction is reversed. This indicates an axis of elevation, or, as it is called, an "anticlinal axis." The beds lie like the ridge of a saddle. Up to this point the dips have been taken in a railway cutting through a hill, but beyond this the cutting ends. The next observation is on the banks of a stream crossed by the road. It shows 26° NE. Another hill is now cut through by the railroad near the top of this hill, in a quarry where there is a good observation showing a dip of only 20°. In the cutting beyond the amount is reduced to 18°, and on the roadside still farther, nearly out of the map, the dip is found to be only 14°. All these latter dips are in the same direction (NE.) or nearly so.

It is not difficult to translate these observations into a geological phrase, by constructing the section given in fig. 2. An outline of the surface marking the differences of level being obtained, either from contour lines on a map or from observations by an aneroid barometer, the various dips are marked by drawing lines, making proper angles with the horizontal base of the section; and the rocks having been noted in each case, these may be marked in by lines or colours as most convenient. The result is a true section available for reference, and yielding sufficient account of the geological facts to lay the foundation of a geological description.

It is not easy to imagine a simpler method of recording observations of the nature and relative position of strata than sections of this kind. A number of such sections, taken at intervals of some miles asunder in a country not greatly disturbed, will give the material for constructing a geological map, and a map thus constructed contains in fact the record of a number of observations precisely the same in their nature as those from which sections are obtained. When the sections indicate frequent changes in the angle of inclination, whether in amount or direction, the observations must be more frequent, and the nature of the rock itself must be watched with greater care.

Together with sections such as we have just described, there are sometimes means of obtaining accurate observations as to the exact nature and thickness of the rocks in a district where mining work is carried on. In sinking a shaft for a well we obtain also this result. A section of this kind is called a vertical section, and is illustrated in fig. 3. The shaft section there given is that of a coal mine, and in this way accurate knowledge is obtained of the sequence of the rocks; so that by

comparing two such sections, taken at different pits in the same district, the position of the strata at considerable depth is made out. Such sections are equivalent to observations made in very deep cuttings, and extend to many hundred or even thousand feet. They represent hundreds of strata. Where the strata are tolerably regular, and where the general nature of the disturbances is already ascertained, a great deal of most valuable information may be obtained from these measurements and statements. They tell us on a tolerably large scale the average dip and the average thickness of the beds; and by comparing two such sections, and connecting them on paper, exceedingly useful practical knowledge is obtained, and further investigations suggested.

Horizontal and vertical sections strictly correspond with each other, and are only so named because the observations for making the former are taken at the surface, and those for the latter from actual sinkings. By the former we obtain a series of facts concerning strata drawn from surface appearances, but often involving a thickness of many thousand feet. This is only obtained, however, when the strata have been tilted, so that, within a moderate horizontal distance, a number of beds underlying each other crop out in succession. This will be seen by reference to fig. 4, where, if the length of the section (*a b*) represents a mile, the height above the base line (*a d*) will be about 300 feet, and the length of the line *a c*, which represents the total thickness of all the strata cropping out between *a* and *b*, will be about 2,500 feet. Thus a shaft (*a e*) sunk from *a* to the depth of 2,500 feet will give no more information concerning the strata, than would be obtained by observing the edges of the beds, and noting their thickness in making a horizontal section from *a* to *b*. It is, however, by no means certain that the thicknesses of strata observed at the surface are at all the same as those of the same beds at considerable depth, neither is it always the case that the material is the same. What is shale or even clay near the surface may be hard slate rock below, what is soft broken limestone may be very compact solid marble, and what is powdery at the outcrop may be a substance below that would require gunpowder to touch. Thus the horizontal section tells us of the general nature of the rock after it has long been exposed to the action of weather, while the vertical section informs us at once of the real nature of the rock under pressure and without being changed.

It is common enough among geologists to give sections in which some striking and important fact is distorted; and this seems almost necessary when, as is often the case, it is required to limit the section in length and yet represent many facts. The scale for horizontal distances must be, for this purpose, very

different from that used for heights or vertical distances. In other words, a measure of distances in length being assumed to bring so much of a section as is desired within the range of a certain space, a measure of distances in height is assumed quite independently, which shall also exhibit all that is desired. Thus, if it were desired to show a section across five miles of country within the breadth of an ordinary page of letter-press, the scale must be about an inch to one and a half mile (nearly one to a hundred thousand). Now, under ordinary circumstances, the total difference of height in such a section on a tolerably level country would not exceed five hundred feet, and on the scale just mentioned this height would amount to only one-sixteenth of an inch, far too small to admit of the representation of any geological facts. To alter the section so that these facts may appear, there must be a different scale for heights and distances, and the scale will be more or less disproportioned according to the difference of height that has to be represented. But in this there results a distortion which it requires much study to overcome the effect of. The scale of heights in the case represented in the diagrams 4, 5, must be at least ten times as great as that of distances to admit of any adequate representation; and the effect of this is shown in some measure in fig. 5 of the Plate, where the section in fig. 4 is repeated to a scale of which the heights are five times greater in proportion than the distances. It can hardly be necessary to do more than point out to the student how complete a distortion this change makes, but the only alternative is to increase the length of the section. Owing to the necessity for distortion, many geological sections are little more than diagrams, and are very difficult for the student to understand correctly. The distortion when admitted should be carefully borne in mind, and it is hardly possible to base a serious conclusion on a section without reducing it to an equal scale of heights and distances.

Everything connected with the mechanical disturbances of beds and their direct results may be shown conveniently and well in geological sections. Anticlinal and synclinal axes (known under various names), curving and distortions of strata, interruptions of strata, faults and dislocations, veins and dykes, false stratification—all these and many phenomena of stratification, including the peculiarities of structure of rocks, are thus delineated, and in case of need accurately expressed.

The horizontal and vertical sections published in illustration of the Geological Survey Map of England will be found very useful to the student as expressing groups of facts, but they must not be taken as superseding personal observation even in places very near the actual line of country represented. Nor

must they be supposed to be in all cases accurate. Like other observations made for an extensive survey they involve large generalisations, and are useful almost more as suggestions than as completed works. Of the two the vertical are the more valuable, as they are strictly accurate. The horizontal are often little more than expressions in a pictorial form of the facts already stated on the geological map.

The geologist often makes use of sections very roughly drawn, and without any pretension to accuracy, which serve as diagrammatic representations of facts either striking in themselves or important to be noticed. Such rough sections must not be mistaken for true geological sections. They are constructed without much reference to scale or proportion, and they are therefore only valuable for the special purpose for which they are introduced. They may, however, be very useful and instructive, and are entered in the note book on the field or prepared for the lecture-room without hesitation. They are in fact sketches. They differ from artists' sketches in not representing the general features of a landscape, but the geological features of a cliff, a quarry, or a cutting. Grand phenomena of disturbance and of the intrusion of igneous rocks are thus conveniently marked. Of this nature also are the diagrammatic sections that include a considerable distance of country; and they are necessary for this purpose, as it is practically impossible to give accurate sections extending for more than a few miles. In other cases the great and characteristic features of a small district must be magnified, and those that are monotonous reduced. In any case the result, though very useful as giving a general idea of the structure of a continent, an island, or a small district, has no pretensions to strict accuracy. In fig. 6 a section of this kind is given. It is one of a kind whose object is to assist the memory of the student in reference to the main divisions of rocks. The particular diagram refers to the rocks as developed in England, and gives in a rough way an idea of what would be seen in crossing our island from Suffolk to Wales. In such a trip the various groups of rocks would be crossed in regular order, beginning with the Tertiary Crag in the East, and ending with the oldest known stratified rocks on the Welsh coast. The distance is 250 miles or thereabouts, the extreme height about 3,000 feet. The scale of heights to distances is therefore about one-sixtieth; in other words, an inch of the section represents about 60 miles in length and about 5,000 feet in height. But there is no attempt at an actual representation of relative heights or of the proportionate development or relative importance of any of the groups. The total thickness of strata represented is upwards of 30,000 feet, but in all probability, if a deep shaft were sunk in Suffolk, the

lowest beds would be reached before even the first ten thousand feet were sunk to. The lines even in a carefully prepared section cannot be continued far beyond what is known by observation without great risk of error.

It will be evident that there is a great difference between the two kinds of geological sections we have been considering. One kind is deduced from minute observation and measurement; the other is the expression of generalisations from these facts. The one is positive and belongs to the region of recorded facts; the other is a diagram useful for illustration. This fundamental difference must never be lost sight of by the student, and he should be prepared to make use of the one as well as the other.

Among the modes in which the second kind of geological sections are employed, may be mentioned their use in illustrating and explaining theoretically views in various departments of geology. The construction of coral islands and the mode in which large deep reefs are formed is one of them. In fig. 7 will be seen an ideal section, intended to illustrate the view of their construction taken by M. Darwin, and since almost universally accepted among naturalists and geologists. An island is seen in the open ocean rising out of a lagoon or large shallow lake of salt water, and the bottom and rim of this lagoon consist entirely of coral. Outside the lagoon the water deepens with great rapidity, but it is found by soundings that the coral bottom continues for a very great depth. Now it is known by observation that the living coral animals of the larger kinds, such as build up these vast walls, do not live at great depths, apparently failing to find air or food sufficient for their purposes below a limited number of fathoms. As the depth at which the large coral is found is very much greater than that at which it can be constructed, it is assumed that the island must have been continually sinking during the growth of the coral. Originally a large island was probably above the water, the land reaching to within a few fathoms of the lowest point of the coral. A reef grew round it, and while growing the island gradually sunk. The sinking must have been sufficiently slow to allow of a perpetual upward growth of the coral; and thus in time those vast masses have been accumulated which are now some hundred fathoms deep, and which fringe the whole island like a wall. The use of the diagrammatic section to illustrate this view of a very curious phenomenon is easily recognised. For the purpose for which it is needed, the diagram is as good in all respects as if perfectly measured to an accurate scale of equal heights and distances.

In practical geology sections of both kinds are valuable. Occasionally very carefully measured sections of small parts of

a coal field are made, and are found to assist greatly in planning and executing works underground. Accurate sections connecting different shafts and different parts of the works are necessary, and these, among other facts, prove the nature and position of the rocks. But they are not strictly geological sections. Sections made in working metal mines are also valuable to the geologist, but they are too technical to be included among those here described. Occasionally, however, sections are obtained illustrating the effect of upheavals and movements which are both curious and important in a geological sense. An example of this is given in fig. 8, where a view of the intersection of mineral veins by dykes and elvans introduces and solves a problem of apparent difficulty in the mechanics of geology. In this case *a a′* represents a lode or mineral vein, which has been disturbed and removed in position by the intrusion of dikes *b*, *x*, *y*, and the movements that have been connected with their presence. In the case represented *a a′* is a metaliferous vein, and has originally been in the position now shown by the upper part of *a*. Several elvans or dykes introduced one after another have then disturbed it, and given the whole section the intricate appearance it now presents.

A geological section affords a simple and easy means of illustrating the way in which a supply of water is obtained from the interior of the earth. Fig. 9 represents several of the more common methods, and is a useful diagram without strictly copying nature in any one district. In this diagram the water-bearing rock of a group of strata, marked 4, is represented as cropping out at some points and going down to a considerable depth at others. At the point marked *b*, it comes to the surface on the slope of a hill, and at this point the water descending the hill will tend to escape. It will then appear as a spring or a row of springs bursting out at a certain level on a hill side. At another point, marked *c*, there is a fault, and there the water that does not escape at *b*, as well as some of the drainage between *b* and *c*, will rise and tend to get away. At the same point *c* there will be from time to time an overflow from the same water-bearing bed, from the other side of the fault. At a third point, *d*, a crack in the strata, or a well sunk to a certain depth, will enable the water retained under pressure, above the strata marked 4, to rise either to the surface or to a certain height, and thence either flow away or re-enter the strata at a higher level.

There are many other ways in which geological illustrations and facts are conveniently expressed by sections, and for the most part they are simple and easily understood. Natural sections, or sections obtained on the sides of cuttings, must not,

however, be accepted without investigation. They are very often fallacious, representing angles of inclination incorrectly, owing to the exposed section not being at right angles to the strike, and not less often deceptive, as inducing the careless observer to accept as general that which may be accidental or a special exception to a rule. False stratification (already alluded to) seen in a small section may be mistaken for real; nodular structure may be mistaken for contorted bedding; slight nips and small bends of strata, the result of squeezing, may appear to represent great disturbance; and the confusion in bedding produced in the axis of a very unimportant dislocation may seem to refer to far more important movements. Thus, natural sections must be regarded only as suggestions, and each one must be supplemented by others taken both near and at a distance to determine the real section.

Without in any way exhausting the subject, we have already gone over a long list of occasions in which geological sections are useful and instructive. It is indeed difficult to know in what other way so many and such valuable facts could be so well represented. The sections are a picture language appealing at once to the eye and the intellect, saving long descriptions, and capable of being wrought up into almost any degree of accuracy when required. But in proportion as they are easily made and easily understood they require to be carefully looked after. They may be misunderstood either by giving them credit for accuracy that does not belong to them, or by the want of a due consideration of the exaggerations and disproportions that so often accompany them. Very few geological books give real sections. The great majority of purely geological and technical memoirs make no pretensions to accuracy in this respect. In them generally sections are used as diagrams to express certain facts and save long description. In this light they are eminently useful if thoroughly understood. Perhaps the account here given may assist some of our readers to regard them in the right light, and assist in rendering the ideas of the rising geologists definite in matters of stratification.

DESCRIPTION OF THE PLATE.

FIG. 1. Topographical map to assist in a proposed geological section of the country represented.

2. Section illustrating the geological structure of the country in the map :—

References. 1. Shales broken by an anticlinal axis. 2. Sandstone. 3. Shales. 4. Sand. 5. Limestone. 6. Gravel.

„ 3. Vertical section of a coal sinking.

„ 4. Section exhibiting the sequence of a large number of rocks to a great thickness by surface observations.

„ 5. Section corresponding to fig. 4, but having the scale for heights double that for distances.

„ 6. Ideal section through England :—

References. 1. Silurian. 2. Devonian. 3. Carboniferous and Permian. 4. Triassic. 5. Lias and Oolitic. 6. Lower Cretaceous. 7. Chalk. 8. Tertiary (Crag).

„ 7. Section illustrating the proposed origin of certain kinds of coral islands.

„ 8. Section illustrating the results of intersection of a mineral vein by two dykes or elvans.

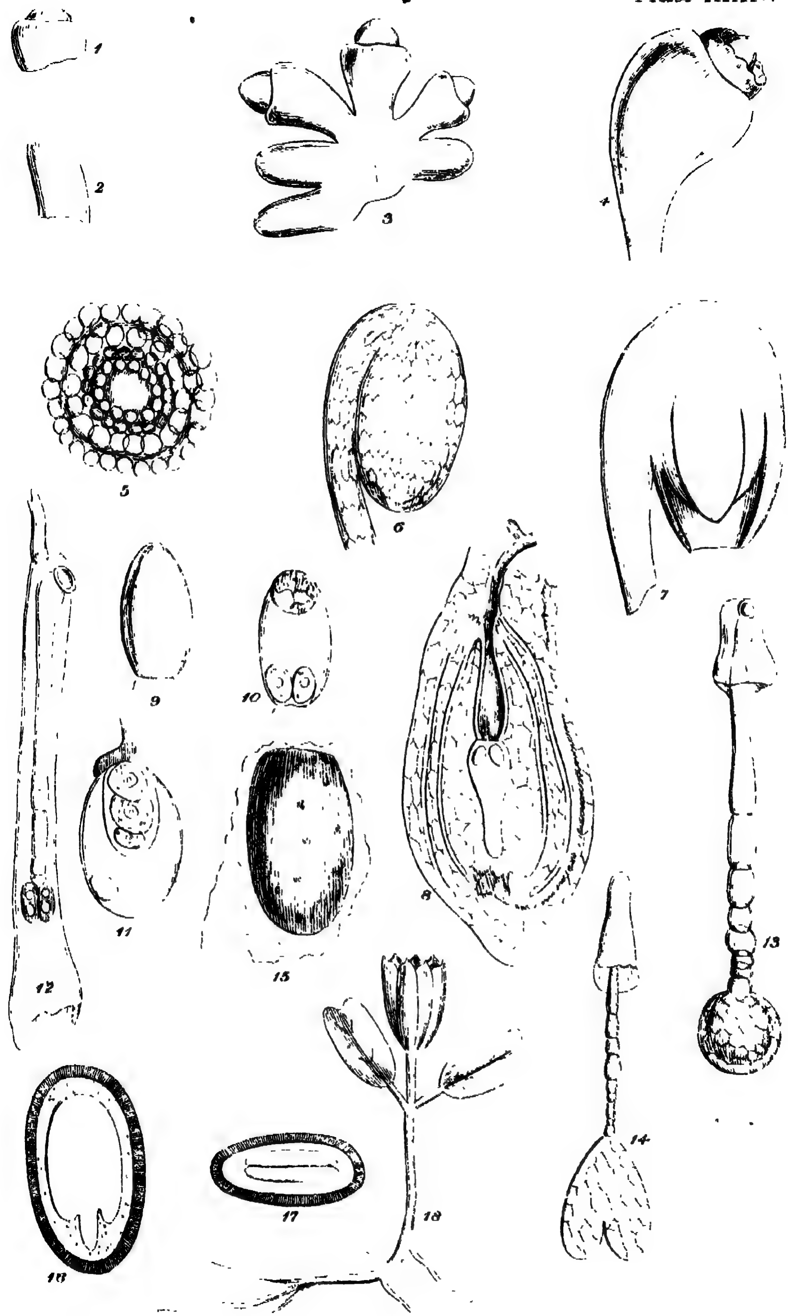
„ 9. Section illustrating the origin of certain springs.

THE LIFE OF A SEED.

By MAXWELL T. MASTERS, M.D., F.L.S.

THE word "seed" is in such common use that we do not imagine that any one troubles himself to look into a dictionary to ascertain its meaning. Perhaps it is just as well that he does not, as ordinary intuition will supply as good an explanation as that afforded by Johnson, or rather by More, as quoted by the great lexicographer, and who states that a seed is "the organised particle produced by plants and animals from which new plants and animals are generated." Assuredly this definition will not satisfy the naturalist now-a-days. There would to most persons seem to be a great fitness in the use of so convenient and expressive a word as "seed," one so easily remembered, so readily understood, so free from ambiguity, so unlikely to be misapplied. But ask a botanist as to these points, and he will tell you that in many cases the so-called seed is confounded with the seed-vessel, while even botanists themselves constantly make use of such slipshod expressions as "germination of the seed," when they mean to speak of the growth and development of the embryo-plant encased within it. After this, when Miss Flora speaks of her "seeds coming up nicely," let no learned botanist smile in the fancied superiority of his own accuracy of expression. When St. Paul says, "That which thou sowest is not quickened unless it die, and that which thou sowest, thou sowest not that body that shall be, but bare grain, it may chance of wheat or of some other grain; but God giveth it a body as it pleaseth Him and to every seed his own body," he expresses a literal truth (apart from all metaphorical application) with far greater precision and accuracy of language than is generally employed by gardeners or botanists when they are speaking of the phenomena of germination. In the case of men of science the inaccuracy is not of so much consequence, as they are quite aware of the fact, and no inconvenience arises; but with the laity, if they may so be called, the case is different. The expressions in question are apt to be considered as correct, and erroneous notions consequently prevail. Perhaps the following

Plate XXXV.



J. E. Sowerby del.

Life

contribution to the life-history of the seed may do somewhat towards rendering the matter more clear, if only by pointing out the pitfalls engendered by the use of erroneous expressions.

Like infants who at birth are provided with a double set of teeth, ready to emerge from the recesses of the jaw-bone when occasion demands, so, the flower has hardly assumed even infantile proportions, hardly completed the number of its component parts, ere indications of provision for the future are manifested. Long before the blossom has arrived at maturity, when it is so small even as hardly to deserve the name of bud, even so soon does careful Nature begin to make provision for the perpetuation of the plant. It forms no part of our purpose to trace how the flower grows and how its component parts manifest themselves in successive order; suffice it here to say, that scarcely is the future seed-case or pistil apparent in the embryo bud, than traçes of the seeds appear likewise. It may not sound very romantic to trace the origin of a lovely rose or a giant oak to a pimple; but, whether or no, no higher origin can be assigned to them, or indeed to any living creature whatsoever. Even the pimple is not the actual commencement, being, as Mr. Herbert Spencer would call it, an aggregate of the second order, in other words, a mass of cells so arranged as to form a little roundish prominence or tubercle. This, then, must be our starting point in tracing the history of the seed. Up to a recent period it was considered that these seminal tubercles invariably originated from the margins of the carpellary leaves, from the edges, that is to say, of those leaf-like organs which, when placed in apposition or united together, constitute the ovary. Now, however, it is pretty generally conceded that the ovules or young seeds may be found not only on the edges, but on the surfaces of the leaf-organ (carpel), and in other cases from a little prolongation of the stem of the plant, which thrusts itself up into the cavity of the carpels, and thus arise the different modes of "placentation" mentioned in the text books. With this matter we need not here concern ourselves; let us return to our pimple, which, to be more precise, we may call in future by its technical name of nucleus.* As it grows in size it generally happens that a ring of cellular tissue forms around its base, this ring elongates into a tube or sheath, leaving a little opening at the top, the foramen, the purport of which will be apparent hereafter. In some cases a second, or even a third sheath forms gradually over the central nucleus, which thus becomes concealed by these sheaths or coats of the ovule, as they are termed.

* Not to be confounded with the nucleus of the cell,—quite a different thing, though, unfortunately, called by the same name.

During the formation of these coats, the direction of the ovule usually undergoes a change; originally subglobose in shape, it becomes more and more egg-shaped. At first resting on the "placenta" without any intervening support, it ultimately becomes raised on a little stalk, "funiculus," which gradually emerges from the placenta, and bears the ovule upwards with it; in the outset straight and without bend, it gradually, as its stalk elongates, becomes more or less curved, so much so, sometimes, as to become completely inverted; the true apex of the ovule, which originally pointed towards the upper or distal end of the ovary, is now turned towards the opposite extremity. While all these changes have been going on on the surface of the ovule, others not less remarkable have been taking place in the interior. The nucleus, or primary pimple, which we left as a mass of growing cells all about of equal size, now begins to show one large cell in the centre, which in some sense might be termed a mother cell. This rapidly increases in size so as very greatly to exceed the adjacent cells, and in it float one or two minute vesicles, which go by the name of the germinal vesicles, and one of which is destined to form the new plant. The ovule is now complete as to its organisation. There are variations in different plants, but in essence, the changes which occur are uniformly such as just described. Here, then, is the ovule complete; it is no seed yet; it would not germinate, using that term in the ordinary acceptation; it may become a seed, or it may, for lack of the proper stimulus, gradually decrease, shrivel, and become obliterated. Speaking broadly, it may be said that of hundreds of ovules scores only become seeds. In some cases, no doubt, every single ovule becomes a seed, but this is the exception rather than the rule. How, then, does the ovule become the seed? In replying to this question we can only do so in general terms. The ashes of a dead controversy are still warm. It is necessary to tread carefully, nevertheless the way is now pretty clearly marked out, and we may walk confidently where, a short time since, fierce conflicts were being waged between combatants of nearly equal prowess, so that for those anxiously awaiting the issue of the controversy, there was but little rest or certainty of belief. Dropping all metaphorical allusions, and returning to the history of the seed, we now come to the period of its fertilisation; to the time when, in consequence of processes to be presently described, a new plant is formed within the ovule, which now for the first time becomes a seed properly so called.

Space will not allow us even to analyse the records of botany, and show by what steps, and by whose assistance, we have arrived at our present knowledge of the process of fertilisation. We must content ourselves, in general terms, with giving, as clearly

as we can, a statement of those phenomena the interpretation of which is now no longer doubtful. Suppose, then, a grain of pollen to have fallen on the stigma, and to be there retained by the hairs projecting from its surface, the next step is the emission of the pollen-tube. This takes place in consequence, apparently, of endosmotic action going on between the fluid exudation from the stigma and the contents of the pollen cell. The latter, distended by the inpouring of additional liquid, bursts, and thus liberates the inner lining of the cell, in the form of a cylindrical tube. Down between the cells of the style passes the marvellous conduit, ever lengthening till it reaches the ovules in the cavity of the ovary. As the length of the style is sometimes very considerable, it was long a matter for surprise that so great extension could be manifested by a single cell, but it has recently been shown that the lengthening of the pollen-tube is due to something more than mere extension, and that an actual growth takes place interstitially, varying in degree and in rapidity in different plants and in consonance with different circumstances. In *Tigridia*, where the style is very long, Dr. Martin Duncan has estimated the rate of growth of the pollen-tube at one inch in four hours and a half, though, under favourable conditions of heat and moisture, the rate may be accelerated. But with these variations we must not occupy ourselves now, but proceed to trace the further progress of the seed. Arrived in contact with the ovules, whose structure has been before described, the pollen tube enters into the foramen at the top of the ovule left by the imperfect closing up in that situation of the investments of the ovule, and thus comes into contact with the nucleus, and the large embryo sac already alluded to. In this latter are sundry minute vesicles, some at the top and others at the other extremity of the sac. With the latter we need not here trouble ourselves, as their existence has not been made out in all cases; where they are found they appear to be transitory only, while their purport is at present wholly unknown.

With the little vesicles in the upper end of the embryo sac, generally two or three in number, the case is different. These form what botanists call the germinal vesicles, and the consequence of the application of the end of the pollen-tube to the upper end of the embryo sac just over these vesicles is soon seen in the rapid growth of one or sometimes two of these latter bodies, and which in the course of a short time lengthens into a slender cellular thread, at one end of which is formed the embryo plant, at first a mere globe of cells, but in dicotyledons speedily becoming marked out into a radicle or primary root at one extremity, while the opposite end divides into the two cotyledons. How or why this result follows immediately on the contact above described is a profound mystery; there

is no visible penetration of the embryo sac, though it may be indented by the pollen-tube. There may be endosmotic action in play again here: but speculation is useless; in this matter we are for the present foiled, and can no more tell why a germinal vesicle, a mere dab of protoplasm, takes on, all of a sudden, active growth and evolution, as a consequence of the near proximity of the pollen-tube, than we can explain the reason for the segmentation of the ovum, which happens as a consequence of contact with the spermatozoon. Here we must wait patiently for further information. Some observers treat these as ultimate facts, and state that we shall get no further; but this is too bold a statement to be received nowadays, as, although there are limits beyond which finite sense of reason cannot penetrate, it surely cannot be said that we have attained those limits at present.

The seed, then, it will be seen, is the ovule, with an embryo plant developed within it. This is, however, not the whole truth, as, during the development and growth of the embryo, considerable change takes place in the coats of the ovule. Every one must have remarked the astonishing variety in the form and appearance of the seed. Hard seeds, soft seeds, round seeds, flat seeds, seeds angular, seeds cylindrical, seeds as large as an ostrich's egg (cocoa-nut), seeds so small that they might well be mistaken for grains of dust, seeds as smooth as the bore of an Armstrong gun, seeds beset with spines as thickly as a hedgehog's back, seeds pitted like a honeycomb or as thickly studded with pimples as Bardolph's nose, now covered with long silky white hair (cotton), in other plants invested with thick close felt, or encircled by a membranous wing, now nestling in juicy pulp, again wrapped round in a fine scarlet mantle or arillus (Nutmeg, Spindle-tree). There is really no end to the varied appearances of the seed; and if, to go a step further, the binocular be turned on it, what a wealth and variety of form and disposition in the cells of its testa or covering, every whit as much diversity in internal organisation as in outward conformation! The observer who wishes to gain some insight into the variations in the structure of the covering of the seed in one natural order only, should read Mr. Tuffen West's paper on the seed of *Solanaceæ*, and study the author-artist's illustrative drawings.* We must not pursue this part of the subject further, our object in alluding to it at all was simply to contrast the uniformity in the structure of the ovule with the immense diversity that exists in the seed. The range of variation in the one case is enormous,

* "Proceedings of Botanical Congress," London, 1866, p. 182, tables IX., X., XI.

in the other but little. The coats of the ovule then become the investment of the seed, after having undergone no slight amount of change of appearance.

The nucleus, our starting point, either becomes obliterated as the embryo plant grows, in which case the latter, when fully developed, occupies the whole of the seed, and is immediately covered by the seed-coats, or it remains behind in the shape of the "perisperm" or "albumen," and which, like its namesake in this particular if not in others, serves as a storehouse whence the embryo plant derives its nourishment during the course of its development. If there is no albumen, then the little plant draws upon itself, and from its large cotyledons derives the dextrin and other soluble matters which it requires during germination.

To this last process we must now devote a few words. It is one of those daily phenomena which we look on as matters of course, never thinking that it is as much a subject for marvel and for gratitude as any miracle, never realising that, but for the life within the tiny seeds, this earth, with all its beauty and all its bounteous stores of nourishment, would be a dreary, desolate, lifeless waste. The main facts relating to germination are so familiar that it is needless to dwell upon them, but some of the changes which occur during the process are not so familiar, and may be briefly alluded to. To state the matter in a few words, the case stands thus: given a perfectly constructed seed and a sufficient degree of heat, moisture, and oxygen, and germination will ensue whether the new plant begin life on a wet flannel, such as sailors are said to use in raising a salad on board ship, in the maltster's heap, or in the carefully tended seed-pan of the florist.

The physical alterations, or those that are visible to the eye, are of less interest than the chemical changes that ensue during the process. While the former consist merely in the swelling of the seed as it imbibes water, the protrusion first of the root of the embryo through the foramen, and subsequently of the remaining portions of the young plant, and the gradual disintegration of the seed as the seedling increases in size, the latter are far more complicated, and, indeed, can hardly be said to be thoroughly understood even by chemists themselves. Some of the main facts, such as the emission of carbonic acid gas, the conversion of the starchy matters into dextrin, gum, and sugar, the replacement of the insoluble fatty materials by others of a more soluble nature, and therefore more suitable to the requirements of the growing embryo, have long been known, as also has the evolution of heat, which occurs as a consequence of these changes.

With reference to the solution of the starch grains during

germination, M. Gris has put on record within the last few years some interesting observations, and from which it appears that the starch grains are dissolved in various ways, according perhaps to the form of the grain; thus, when the starch grains are simple in character, they are dissolved irregularly, the solvent agent, whatever it may be, attacks them locally, or with greater intensity at one place than at another. On the other hand, grains that are compound or aggregate in character diminish in bulk gradually over the whole surface, so that the mass melts away insensibly.

There is still much to be learnt as to the exciting cause of these phenomena, though much has been ascertained (in addition to what has before been alluded to) both as to what does and what does not facilitate germination. It was natural, for instance, to suppose that germination would be stimulated by electricity; this, however, does not prove to be the case. With reference to the action of light, the statements of different experimenters are at variance one with another, though the balance of evidence seems to be in favour of the opinion expressed by Mr. Hunt, that the blue rays promote germination, while the yellow light-giving rays impede it. It too often happens with regard to these and similar experiments, that no fair comparison can be made, no just inference drawn, because observers have not made use of the seeds of the same plant, or if of the same plant not in the same condition. It is necessary to bear this in mind, as it is well known to botanists, that the varying structure of the seed and the embryo are coexistent with variations in the process of germination. Some seeds, for instance, are capable of germination, and in effect do germinate, while still immature; thus wheat has been observed to grow while yet the albumen is milky. Again, an embryo plant that derives its nourishment, in the first instance, from the albumen with which it is encircled, shows a greater proportionate tendency to the development of leaves than of flowers, than does an embryo plant which has no such store of nutriment to draw upon. The perisperm, or albumen, thus acts in the same way as a too fertile soil would do—encourages the tendency to form leaves, rather than flowers. These are facts which cultivators should bear in mind, as they are of no little practical importance. In the same way it is more than probable that the diversities in the length of time with which a seed will conserve its vitality without germination, the temperature required for exciting that process, and the length of time occupied in its accomplishment, are all more or less dependent on the structure of the seed. But we must not follow these details further: our object has been to trace the history of the seed in a general way from its origin to its consummation in the deve-

loped embryo, not to dilate on the peculiarities of special seeds, nor on the varied circumstances which produce deviations from the customary course of things in the great majority of seedlings. We have, we trust, said enough to show how full of interest for observers of very varied tastes and capacities, are the phenomena connected with the life of the seed, while the intrinsic importance of the subject is shown, not only by the peculiarities of the embryo plant, and its mode of germination being made the chief distinguishing features of the various groups of plants, but also because on the due performance of these functions we are dependent for our daily bread, in a far wider sense than the words in their literal acceptation would imply.

EXPLANATION OF PLATE.

FIGS. 1 and 2. Ovules of Passiflora from a bud about half a millimetre long.

FIG. 3. Portion of the placenta from the same flower, showing ovules in various stages of development.

„ 4. Ovule in process of formation, showing a central nucleus and two coverings.

„ 5. Top-view of No. 4.

„ 6. Fully developed ovule.

„ 7. Longitudinal section of the same.

„ 8. Longitudinal section of ovule of Œnothera, showing passage of pollen-tube to embryo sac after Tulasne.

„ 9. Embryo sac of Orchis—early stage.

„ 10. The same with the germinal vesicles.

„ 11. The same after contact with the pollen-tube, showing the development of the germinal vesicle into the embryo.

„ 12. Portion of the embryo sac of Iberis after contact with the germinal vesicle: a suspensor is here formed at one end of which is the embryo.

„ 13. Further stage in Iberis.

„ 14. Still further degree of development, showing division into two seed-leaves.

„ 15. Ripe seed of passion flower, the arillus torn.

„ 16. Vertical section of the same, showing testa albumen and embryo.

„ 17. Cross section of the same.

„ 18. Germinating embryo of Galium.

REVIEWS.

THE INSECT WORLD.*

OF all the classes of that great sub-kingdom of the Animal world—Annulosa —there is none which has in all ages received so much attention as that of Insecta. And this is not to be wondered at when we consider how manifold are the types of structure which it embraces; how exquisitely beautiful are the colours of many of its species, how marvellous the instinct (or reason) displayed by them, and how useful to mankind the products of their labours. They have supplied objects for observation to men of all classes and in all times, and they have been the creatures selected by the closest students of animal life which the world has produced. Dr. Geer, Réaumur, and Huber all made themselves famous by their studies of insects, and much as they have done to extend our knowledge, there is far more yet to be acquired of insect modes of life, than what is recorded in even our most recent works. It is required, then, to foster a love for the study of entomology—of entomology in its widest sense. Not the mere dry-as-dust pedantic abomination, which some of our impalers of unhappy flies would make the pursuit; not the brain-degenerating study which finds its highest aim in the discovery of a variety which is straightway named in sesquipedalion dog-Latin; but the entomology of the great men whose names we have mentioned—an entomology corresponding to Mr. Darwin's study of botany—a study which helps to reveal natural phenomena and extend our knowledge of natural laws. This is what we want, but what we shall probably have long to wait for, till books like this one of M. Figuier's have shown the young naturalist what a grand field of exploration lies before him. Kirby and Spence's excellent work has doubtless done much, but it was a badly printed, unattractive volume; and the multitude of works which have succeeded it have been of the taxological order of the most devoted species-hunter. In the fine volume which Messrs. Chapman and Hall have published we find a true, though by no means very modern natural history of insects. The author describes the general character of the class, and then divides it into the orders to be found, in most of our text-books. Under each order he describes the typical families, genera, and species, and goes not only into general natural history, but where it has a

* "The Insect World, being a Popular Account of the Orders of Insects, &c." From the French of Louis Figuier. Illustrated by 554 woodcuts. London: Chapman and Hall, 1868.

special bearing, into comparative anatomy and physiology. The text is clear and vigorous, the illustrations in the great majority of instances faithful to nature, in some cases merely fanciful and picturesque, but in all thoroughly artistic. M. Figuier does not pretend to know much about his subject, but by the judicious use of his scissors, and the necessary amount of upholstery, he has given us as it were a scrap-book of entomology from the principal older writers on "the life and manners of insects." It would be impossible to give our readers many instances of M. Figuier's mode of resorting to natural history writings, but we may select one as a type of all. In describing the curious Cercopidæ, he wishes to explain the origin (which cannot even now be regarded as thoroughly established) of the peculiar froth which surrounds the pupa, and he thus quotes from that master of observation, the Swede de Geer :—

"It begins," says the Swedish naturalist, "by fixing itself on a certain part of the stalk, in which it inserts the end of its trunk, and remains there for a long time in the same attitude, occupied in sucking and filling itself with sap. Having then withdrawn its trunk, it remains there, or else places itself on a leaf, where, after different reiterated movements of its abdomen, which it raises or lowers and turns on all sides, one may see coming out of the hinder part of its body, a little ball of liquid, which it causes to slip along, bending it under its body. Beginning again the same movement, it is not long in producing a second ball of liquid, filled with air like the first, which it places side by side with, and close to, the preceding one, and continues the same operation as long as there remains any sap in its body. It is very soon covered with a number of small balls, which, coming out of its body one after the other, tend towards the front part, aided in this by the movement of the abdomen. It is all these collected together which form a white and extremely fine froth, whose viscosity keeps its air shut up in the globules, and prevents its froth from easily evaporating. If the sap which the nympha has drawn from the plant is exhausted before it feels itself sufficiently covered with froth, it begins afresh to suck, until it has got a new and sufficient quantity of froth, which it takes care to add to its first state."

Of course the book cannot be looked upon as anything higher than a treatise for young people, since—as in the explanation of a sexual reproduction of Aphides—the very best modern researches have been left unnoticed. But in this particular it takes a good rank, and is worth more than many such works as the "Ocean World," "The World before the Deluge," and so forth. Messrs. Chapman and Hall have taken care to have the book edited with care, and though we think it a pity that the editor did not, in addition to pointing out M. Figuier's errors, attempt to bring the work up to the time, we must on the whole compliment him on the result of his labours. The translation follows the French very closely, but without that disfiguring reproduction of Gallic idioms which so defaced the English reproductions of other of M. Figuier's writings. Indeed, in one or two instances the translator's conscientiousness has led him to reproduce passages which are regarded as humorous on the other side of the Channel, but which to English readers of refinement are remarkable merely for their coarseness and vulgarity. We will only quote the following, which might

with advantage have been omitted. In writing of the Aptera and describing the integument of the common flea, the author says:—"It is the breaking of this hard skin which produces the crack which is heard when, after a successful hunt, one has the happiness to crush one of these parasites between one's nails." The publishers have aimed at producing a drawing-room series, and they should avoid anything suggestive of the practical hygiene of Seven-dials and Whitechapel. The illustrations do not equal those of the French edition; a circumstance, we apprehend, due, not so much to any defect in English "working," as to the fact that the French employ an unglazed paper, which is better adapted to the reception of delicate shadings than ours is. In other respects the English is fully equal to the French volume, and we give it our general approval.

RELIQUÆ AQUITANICÆ.*

PARTS VI. and VII. of this luxuriously printed and illustrated work are now before us, and the highest praise we can give them is to say that they are fully equal to all the preceding issues. The first of the two numbers under notice continues the account of North American implements, uncompleted in Part V., and includes a very interesting letter on this subject from Mr. Robert Brown. Then follows an account of the human bones found in the cave of Cro-magnon in Dordogne. This is by M. Pruner Bey, the celebrated anthropologist, and is of considerable value. In this cave were found the skeletons of four adults and one immature infant. There are, says the writer, more or less perfect skulls and some bones of the extremities of three fully-grown individuals, together with ribs, vertebra, and fragments of a pelvis and collar-bone. Of a fourth individual there remain only some portions of the calvarium, half of the upper alveolar process, and a piece of the jaw. Some bones of a fœtus were, singularly enough, also found here. Among the collection, the skeleton of an old man, whom M. Pruner Bey regards as the head of the family, are best preserved, having been covered by a thin layer of stalagmite. The detailed description of the size and processes of these bones is too technical for our pages, but we may say that they do not indicate any very marked inferiority of cranial development. The plates in Part VI. are six in number, and delineate the skulls in different aspects—the last plate being devoted to representations of the long bones. The figures are tinted, to represent the colour of the original specimens, and they are the very *beau ideal* of artistic beauty and excellence of anatomical drawing. While the *tout ensemble* is faithful to the original objects, the attention to details is shown in the fidelity with which the natural sutures and the injuries affected by post-mortem exposure to external influences are brought out. Part VII. contains

* "Reliquæ Aquitanicæ, being Contributions to the Archæology and Palæontology of Périgord and the Adjoining Provinces of Southern France." By Édouard Lartet and Henry Christy. Edited by T. Rupert Jones. Parts VI. and VII. London: Baillière. 1868.

a descriptive account, accompanied by woodcuts, of the cave of Cro-magnon, and some general remarks by M. E. Lartet on the burial-place of the cave-dwellers of Périgord. The sections show how large a quantity of matter had accumulated in the cave, and how great must have been the difficulty of making the necessary excavations. M. Lartet describes a number of interesting relics and fossils found with the human remains. Among the former we may mention a curious necklace made of shells of the periwinkle and whelk, a sort of amulet or pendant of ivory—oval, flat, and pierced with two holes. The presence of the remains of an enormous bear, of the mammoth, of the great cave-lion, and the reindeer, shows the great antiquity of the deposits. These and certain other facts lead M. Lartet to refer "this station of Cro-magnon to the age immediately preceding that artistic period which saw in this country the first attempts of the engraver and sculptor." Of the plates in this number, four are devoted to flint, bone, and other weapons, and one contains a full-size representation of the necklace of shells and the amulet. Every new number of this work strengthens our conviction that, when completed, it will be the finest contribution to prehistoric archæology in any language.

POPULAR ASTRONOMY.*

OF the two books which we have here classed together, the first is one of Messrs. Macmillan's excellent scientific series, the second one of Mr. Hardwicke's no less valuable handy-books. Both are addressed to beginners and amateurs in astronomy; but Mr. Lockyer's volume takes rather a higher, and of course a more systematic aim, than Mr. Proctor's. Indeed, the differences between the two are these: the first is intended to be read by those who know nothing about the subject, and therefore embraces all that relates to the chief phenomena and the generalisations of the science; the second offers itself to the student—amateur or professional—who has already mastered the elements of the subject, and wishes to make himself practically conversant with the heavens. They are both admirable contributions to our literature, but, while we should advise those interested in astronomy to possess the two, we should say, "Study Mr. Lockyer's book first, and then you can take up Mr. Proctor's 'Half-hours' with the greatest advantage and the least difficulty." As we should have expected, Mr. Lockyer has brought his book up to the latest advance in scientific research, and the spectroscope and chronograph are briefly but most intelligibly described. He is nothing if not clear, and though he carefully abstains from what is styled popularisation, we think that even to those unused to scientific reading this book presents no insurmountable difficulties. He deals with his subject in nine chapters, whose headings are shortly as follows:

* "Elementary Lessons in Astronomy." By J. Norman Lockyer, F.R.A.S. London: Macmillan. 1868.
"Half-hours with the Telescope." By R. A. Proctor, B.A., F.R.A.S. London: Hardwicke.

"The Stars and Nebulæ;" "The Sun;" "The Solar System;" "Apparent Movements of the Heavenly Bodies;" "The Measurement of Time;" "Light—the Telescope and the Spectroscope;" "Determination of the Apparent Places of the Heavenly Bodies;" "Determination of the Real Distances and Dimensions of the Heavenly Bodies;" and lastly, "Universal Gravitation." The chapter on Light is a very model of how a book on optics should be written; and by departing from the abominable system of representing pencils of light adopted in most books, the author has rendered the action of lenses a simple matter for even the comprehension of a schoolboy. The frontispiece contains several well-coloured diagrams of solar, stellar, and nebular spectra, and will be useful to the teacher.

Mr. Proctor distributes his half-hours over the following subjects:—"A Half-hour on the Structure of the Telescope;" "A Half-hour with Orion, Lepus, Taurus, &c.;" "A Half-hour with Lyra, Hercules, Corvus, Crater, &c.;" "A half-hour with Bootes, Scorpio, Ophiucus, &c.;" "A half-hour with Andromeda, Cygnus, &c.;" "Half-hours with the Planets;" "Half-hours with the Sun and Moon." Mr. Proctor is so well known as one of the best teachers, that it is almost unnecessary to say anything of the character of his "Half-hours." Like his other writings, they present a sort of royal road to the student. The author, when he takes up his pen, remembers the trouble and difficulties of his own first efforts at observation, and he spares no pains to remove these obstacles from the young worker's path. Indeed, of all our writers on astronomy, he is *par excellence* the one of whom we should say, "If you find any difficulty in carrying on your researches, consult him, and if it is possible, in the absence of verbal demonstration, to obviate your difficulties, he can effect it for you." His chapter on the "Structure of the Telescope" should be read and remembered by everyone who wishes to understand this instrument.

HOW TO AVOID EPIDEMICS.*

HYGIENE as an art is a practical expression of the old maxim that prevention is better than cure, and those who know anything of our great epidemics, or even of our small ones, are aware how very possible it is, by the adoption of certain simple rules, to stay the progress of even the most formidable infectious diseases. Some think that a work in which practical hygiene is dealt with, should be alone addressed to professional readers. But this idea is clearly a mistaken one. It is the public who first come in contact with the epidemic enemy, and it is unfortunately too often the case, that when the physician is called in, the infection has laid hold on the locality in which it first appeared. Now it is, to our mind, extremely advisable that the general public, and especially mothers of young children, should be not only able to recognise the earliest approach of infectious disease, and be acquainted with the most efficient measures for its ex-

* "Notes on Epidemics for the use of the Public." By Francis Ed. Anstie, M.D., F.R.C.P. London: Hodder and Stoughton. 1868.

tinction, but should be familiar with the means of preventing the development of such maladies. To educate the people on these points has been Dr. Anstie's aim, and we must say that he has discharged his task with clearness and ability. Such diseases as typhus and typhoid fever, epidemic diarrhœa, scarlet fever, measles, diphtheria, small-pox, whooping-cough, and influenza, are unhappily too well known to dwellers in cities, as Dr. Anstie's statistics fully prove. Let us take London alone as a sad example of the ravages of epidemic disease. In the thirteen years, from 1852 to 1864 inclusive, the deaths from zymotic (epidemic) diseases numbered 218,998—nearly quarter of a million—"of these 41,664 were caused by scarlet fever and diphtheria, 18,256 by measles, 26,892 by whooping-cough, 13,160 by cholera, 29,995 by diarrhœa, 31,937 by typhus, and only 1,168 by influenza." There is a bill of mortality which we paid for our neglect of hygiene, our parsimony in water and our disregard of cleanliness. Let those who would banish these terrible records from our Registrar-General's returns read Dr. Anstie's book, and see how, by the adoption of the rules of preventive medicine, this black list may be erased from our public statistics. The author of the work does not address himself to the subject of "domestic medicine" or "domestic druggery" as it should be styled. He tells his readers how they may detect the affection, and then he cautions them to lose no time in placing the patient in the care of his medical attendant. There is one point to which Dr. Anstie calls attention, and which has much scientific interest attaching to it. It is the application of the thermometer to the detection of the febrile diseases (maladies which include nearly all the epidemics). It is a most remarkable fact, that as a fever settles itself upon the system, and while the patient is complaining of cold and shivering, the blood is absolutely many degrees higher than the ordinary standard of 98° Faht. The thermometer may therefore prove an invaluable instrument in the hands of an anxious and careful mother who fancies her child "has caught a mere cold," but feels much anxiety as to the possibility of febrile symptoms setting in. Of course other general indications of disease must not be neglected. Nor does it follow that high temperature necessarily indicates fever. But for all practical purposes the thermometer may be readily employed by a nurse or mother, and cannot fail to give warning of the very utmost import. The healthy temperature may be reckoned at from 98° to 99° Faht., and any elevation above this indicates serious mischief. If the thermometer, for instance, "rises as high as 101°, the degree of fever may be known to be severe. When the temperature exceeds 105° the complaint is dangerous to life. . . . . On the contrary, if during the first two or three days of illness the temperature never rises above 100° the complaint is probably a trivial one, whatever its exact nature may be." As to the instrument and the mode of using it, the following intelligible instructions are given :—The self-registering maximum thermometer is the most convenient for the use of non-professional persons who are not accustomed to the daily employment of the instrument. No observation should be made till the patient has been resting quietly in bed for at least an hour. The bulb of the thermometer should then be placed deeply in the arm-pit, the arm being folded across the chest, and the bed-clothes so arranged to cover the projecting stem as high as the marking 90° or thereabouts. The

patient must lie perfectly still for about ten minutes; the thermometer may then be withdrawn, when the register will remain stationary at the highest level which the mercury has reached. This book is a cheap re-issue of the first edition, and as it is now within the reach of all, so all, we think, should have it and read it. Precise in all that relates to modern scientific research, suggestive in their treatment of the subject, and terse and scholarly in style, Dr. Anstie's "Notes" take a high rank in the literature of Practical Hygiene, and we trust that their re-issue in a cheap form, while meeting a great want, will remove a greater evil—the blind ignorance of the public on questions of preventive medicine.

THE NOVA SCOTIAN GOLD-FIELDS.*

THE political affairs of Nova Scotia have been recently much discussed, but we fear that the industrial and mineral resources of the country have hardly received the consideration they deserve. The gold fields of the country are unquestionably extensive, and the geological examination of them would lead to the inference that they may yet be found in the highest degree productive. But even in their present imperfectly worked condition there can be little doubt that they are capable of a much vaster and more important development than is generally thought. Innumerable obstacles exist at present in the way of a profitable extension of the gold resources, but that these obstacles are irremovable—as is occasionally alleged—we have no reason to believe. Indeed, the evidence collected from all sources, which the author of this book has laid before us, induces us to believe that Nova Scotia may, under proper management, assume one day a very high degree of prosperity. In the volume before us Mr. Heatherington discusses his subject from every point of view, and thus brings to a focus, as it were, a flood of light which chases away in great measure the clouds of doubt which have heretofore attended projected enterprises in this part of the American continent. Touching the one and most important question—the value of the Nova Scotian gold-fields—Mr. Heatherington does not limit himself to the expression of any opinion of his own, but quotes at considerable length the reports of the several Government explorers sent out to examine the auriferous districts. Professor Silliman, than whom few higher authorities exist, states that "there is no reason to fear that there will be any failure in depth of gold product or strength. The formation of the country is on too grand a scale geologically to admit of a doubt on this point." Mr. Campbell, another of the investigators, testifies to the presence of the gold in considerable quantities, but he is less sanguine in his anticipations of ultimate success. Professor James Taylor also reports that the minerals associated with the quartz are rich in gold, and that frequently masses of gold itself may be seen with the naked eye. Speaking of the

* "A Practical Guide for Tourists, Miners, and Investors, and all Persons interested in the Development of the Gold-Fields of Nova Scotia." By A. Heatherington. Trübner & Co. 1868.

state in which masses of mispickel, sometimes over fifty pounds in weight, are found, he remarks, "this peculiar mineral has always proved highly auriferous in this locality." The surrounding auriferous slate is not less than twelve to fifteen inches at the surface, "and will doubtless be found to increase very considerably with the depth." We have given a brief sketch of Mr. Heatherington's little book, but intending visitants should read it for themselves.

THE AUTHOR OF THE PRACTICAL ELECTRIC TELEGRAPH.*

THIS is a work written by the Rev. Thomas Fothergill Cooke to prove that his brother, Mr. William Fothergill Cooke, and not Professor Wheatstone, was the author of the practical electric telegraph. It is a painful matter, even under the most favourable of circumstances, to have to enter into the consideration of a controversy like the present one, and it is so in an especial degree when the plaintiff's counsel is the plaintiff's brother. So much personality and acrimony are apt to be carried into a discussion which can only be properly conducted by those who are absolutely and entirely dispassionate. For these reasons, no matter how just his cause, we regret to see the Rev. Mr. Cooke appearing as his brother's champion. With the best and the honestest intentions, his mind must be less or more biassed toward one conclusion, whilst it ought to be a very *tabula rasa* in point of foregone inferences. In the brochure under notice Mr. Cooke has set forth his brother's claims in opposition to those of Professor Wheatstone with much force and too much bitterness. The evidence he has brought forward will be read with the deepest interest by all who care to see justice done to the great pioneers of civilisation. But on laying down the book, the inevitable conviction of the reader will be, "the case is too strongly stated, although doubtless no facts have been strained to meet a particular view. Yet there is intrinsic proof of partiality. I cannot therefore form any judgment till I have heard the opposite side." For ourselves, we must reserve our opinion.

THE ANILINE COLOURS.†

THE beauty of the aniline colours and their importance as a staple manufacture render their history a matter of interest to everyone. This history has been previously given, from time to time, in chemical journals, and reports, in so far as its theoretical bearings are concerned. But never till now has any thoroughly systematic effort been made to give a clear

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* "Authorship of the Practical Electric Telegraph of Great Britain; or, the Brunel award vindicated in Seven Letters, &c." By the Rev. Thomas Fothergill Cooke, M.A. Simpkin & Marshall. 1868.

† "On Aniline and its Derivatives; a Treatise on the Manufacture of Aniline and Aniline Colours." By M. Reimann, P.D. Revised and edited by W. Crookes, F.R.S. London: Longmans.

representation of the theoretical and manufacturing aspects of the question in their mutual relations. Dr. Reimann not only gives an admirably lucid exposé of the various manufacturing processes, but has traced down the history of his subject from its first beginning to its latest development. The German edition of the work succeeded well, and the English edition is in advance of the German one, through the care taken by Mr. Crookes to incorporate with it descriptions of all the recent improvements which have been made, both in this country and abroad, since the publication of the original work. The work is further valuable from containing an appendix from the able report of Dr. Hofmann and MM. de Laire and Girard "on the colouring matters derived from coal-tar, shown at the French Exhibition, 1867." The book is well printed, contains illustrations of the apparatus employed in manufacture, and may be profitably read even by those who possess but an elementary knowledge of organic chemistry.

EDUCATION AND TRAINING.*

ALTHOUGH the question of general education may be considered to be excluded from the pages of a journal like ours, yet so many of our readers are interested in the point that we cannot refrain from bringing under their notice the very clever and suggestive essay which lies on our table. We are ignorant of the author, but whoever he may be, he is evidently one who has given careful thought to the very important question he deals with, and who therefore deserves to be listened to whatever may be his views. These views, so far as we have gathered them, are distinctly favourable to a compulsory school education, and to a further development of the means of education provided for the poor by the State. The author is an erudite and vigorous writer, who drives home his cleverly pointed conclusions, with skilfully applied force.

VIS INERTIÆ.†

HERE is a book nicely bound, well-printed on good paper, and abounding in maps, diagrams, and charts, and yet we can only deduce from it that it is what Sterne would term Hobby-horsical. The author has a certain knowledge of meteorological laws, and he writes with tolerable clearness, and yet we can only put him down as an over-zealous enthusiast—one who twists and turns and clips a foregone conclusion, till he fancies he has got it into such a shape that it shall pass as readily into other men's minds as it

* "Education and Training Considered as a Subject for State Legislation, &c." By a Physician. London: Churchill. 1868.

† "A Treatise on the Action of Vis Inertiæ in the Ocean, &c." By Wm. Leighton Jordan, F.R.G.S. London: Longmans, 1868.

did into his own. Mr. Jordan attempts, ingeniously enough, to demonstrate that ocean-currents are due to vis-inertiæ, and in fact are a phenomenon on a large scale similar to that seen when a vessel containing liquid is moved with rapidity. We cannot follow his line of argument. Let those who care for this sort of scientific relaxation attempt it. To us the book demonstrates only what we have already expressed.

LOCAL NATURAL HISTORY.*

THIS excellent volume—the best yet issued—shows us how much valuable work is being done by English naturalists, who are at a distance from the true centres—if such there be—of science. In this volume, besides the letterpress, there are two most noteworthy features: one is an excellent coloured geological map of Northumberland and Durham, prepared by Mr. George Tate; and the other is a beautifully-executed steel (?) engraving of the late Joshua Alder, a name long endeared to the hearts of the old school of Zoologists, and highly respected by even the younger generations, who know him only by his published writings. The expression of the fine old face has been wonderfully caught, and there is a delicacy of half-shades which give an exquisite softness to the lines of the face. Of the matter, extending over more than 300 pages, we cannot speak too favourably. It contains genuine scientific work, which ought to have had its place in the Linnæan Society's "Transactions." It consists of and includes Mr. George Tate's "New Flora of Northumberland and Durham"—the various stations and zones of which find a place in the geological map we have already referred to—thus showing whatever relation may exist between the geological and botanical characters of a district. The first part of this contribution on the geology, climatology, and physical geology of the counties is worthy of the closest study. It suggests many very remarkable points of the highest interest to the philosophic naturalist.

CHAPTERS ON MAN.†

THESE are, in great measure, papers reprinted from the "Anthropological Review," and, in accordance with the spirit of that aspiring periodical, they discuss a multitude of subjects which would excite the diffidence of anyone less intellectually ambitious than an Anthropological Reviewer. For ourselves, we humbly confess our inability to criticise a work which attempts to resolve every metaphysical nebula from the Psyche and Pneuma to moral responsibility and immortality. To those who care more for

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* "Natural History Transactions of Northumberland and Durham." Vol. II. London: Williams & Norgate. 1868.

† "Chapters on Man, with an Outline of the Science of Comparative Psychology." By C. Staniland Wake, F.A.S.L. London: Trübner. 1868.

mental food than for mental digestion, Mr. Wake's remarks will be found highly piquant. His book resembles what is called in England "an Irish stew;" or in Ireland, a "beggar's dish"—a savory compound, full of bits of all kind put together without arrangement, and largely diluted. To be serious, we disapprove totally of this class of book: it leads to nothing, save the inference that the writer has been attempting the mastery of a great many difficult subjects, and has not been felicitous either in forming or arranging his ideas.

LATHES AND TURNING.*

BESIDES those engaged in trade, there are, we believe, many amateur workers at lathes and turning. To such we can recommend this volume. It is comprehensive in its details, is abundantly illustrated, and clearly written. The author is one who thoroughly understands his subject, knows the difficulties of the beginner, and anticipates them. The country gentleman of a "mechanical turn" will find this work a *vade mecum* of the best kind, in all that relates to the special branch of applied mechanics it has to do with.

PAMPHLETS, ESSAYS, &c.

MEDICAL Education and Medical Interests. By Isaac Ashe, A.B., M.B. Dublin: Fannin & Co. 1868. This is the essay to which the Council of the Irish College of Surgeons awarded the second Carmichael prize of 100*l*. The subject may be said to be the present condition of the medical profession, commencing with the student, and discussing the several medical institutions, modes of practice, offices, fees, and so forth. Dr. Ashe's style is not terse, but it is vigorous and flowing. His ideas appear to be those of an honest reformer, and we hope to see many of them carried out. In one respect he has not quite complied with the conditions of the late Dr. Carmichael's will: he has not treated as fully of English medical bodies as he ought to have done. His book is eminently thoughtful and suggestive, and deserves attention.

Report of the First Exhibition of the Aëronautical Society of Great Britain. Greenwich: Richardson. Those who laugh at the notion of aërial locomotion, and regard the Aëronautical Society as an association of visionaries, should read this pamphlet. It is really astonishing to see how much has already been achieved toward the invention of a machine for conveyance through the air. It is one of the most interesting pamphlets we have ever read, describing as it does all the wonderful machines which were exhibited at the Crystal Palace in June and July last.

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* "A Treatise on Lathes and Turning, Simple, Mechanical, and Ornamental." By W. Henry Northcott. With 239 illustrations. London: Longmans. 1868.

Dr. Watters' Doctrines of Life. Reprinted from the *St. Louis Medical and Surgical Journal,* Nos. 3 and 4. 1868. This pamphlet relates to a controversy between Dr. W. B. Carpenter, V.P.R.S., and an American physician, Dr. Watters. The latter accused Dr. Carpenter of appropriating his ideas on the subject of the circulation of the vital and physical forces. Dr. Carpenter replies: "*My* opinions were expressed in a memoir read before the Royal Society, and published in its 'Transactions' in 1850: Dr. Watters' were not published till some months after." From what we have read in this pamphlet we do not believe Dr. Carpenter appropriated Dr. Watters' opinions, and we think it a pity that the controversy should have been broached at all.

The Flight of Bats, Birds, and Insects, in reference to the subject of Aërial Locomotion. By M. De Lucy. Translated by C. B. Fox, M.D. Scarborough. This interesting pamphlet has been published by the Aëronautical Society. It is an application of comparative physiology to the question of aërial locomotion, and is most ably done. The author very carefully describes the different mechanical conditions on which flight in various animals depends, and he thus gives us the philosophical principles on which our efforts to construct flying machines must be based. Dr. Fox has performed his task of translation creditably.

An Essay on the Geology of Cumberland and Westmoreland. By Henry A. Nicholson, D.Sc. M.B. London: Hardwicke. This is a graduation thesis, which obtained the gold medal of the University of Edinburgh in 1867. It is a perfect monograph of one of the most interesting geological districts in England, and will be found invaluable to those who are engaged in trying to solve the tough problems which the geology of the locality offer to the philosopher. It is in great part based on Professor Harkness' late researches, and is well illustrated.

The Woodhall Iodine Spa, Lincolnshire. By R. Cuffe, Esq., M.R.C.S. London: Lewis. Waters containing iodine are often found useful in various scrofulous and rheumatic affections. This Spa is singularly rich in iodine, and may be visited by certain invalids with advantage.

The Scientific Exploration of Central Australia. By Dr. G. Neumayer. From Proceedings of Royal Society, No. 102. Dr. Neumayer points out clearly what may be effected by further exploration, and how exploring parties should be furnished and conducted, in order to obtain the best practical and scientific results.

Musical and Sensitive Flames. By W. F. Barrett. A reprint from the "Journal of the Royal Dublin Society." The author states nothing that he has not already said in this (Popular Science Review) and other journals.

A Synopsis of West African Restiaceæ, and On the Morphology of the Malvales. By M. T. Masters, M.D. These reached us too late for abstract in our Botanical Summary. They are reprints from the "Linnæan Society's Journal," and shall receive attention in our next number.

Bible-Animals. By the Rev. J. G. Wood. Longmans. The several numbers of this work have been received. The book shall be reviewed when completed.

The Drift-beds of Llandrillo Bay. By Miss Eyton. This reprint from the "Geological Magazine" contains an instructive account of the Post Pliocene, and recent drifts of Denbighshire by Miss Eyton. Miss Eyton is a "working geologist," and not a mere "lady-writer," and the opinions she expresses are founded on careful scientific research.

Geological Time. By James Croll. A reprint from the "Philosophical Magazine" for August. The author, whose philosophical speculations are now looked on with the highest interest, tries to fix the probable date of the Glacial and Upper Miocene Period. His enquiries are to be continued, and probably in our next number we shall deal with them more fully.

SCIENTIFIC SUMMARY.

ASTRONOMY.

SPECTRUM *Analysis of Comet II.* 1868.—On July 2, Mr. Huggins communicated to the Royal Society an important paper on the comet discovered by Winnecke a fortnight before that date. He found that on June 22 the comet presented in the telescope the appearance of a circular coma, at the centre of which there was a nearly circular spot of light. A faint tail could also be traced to a distance of about one degree from the nucleus. In the spectroscope the comet's light was resolved into three broad bright bands. The brightest extended from near *b* about three-fourths of the way towards F; another lay beyond F: and the third band was between D and E. In the two former bands the light was brightest towards the less refrangible end of the spectrum, and diminished towards the other end. The third band was brightest in the middle. The bands could not be resolved into lines. The spectrum of the comet was found to agree *exactly* with a form of the spectrum of carbon obtained by taking induction sparks through olefiant gas. This form of the carbon spectrum had been observed by Mr. Huggins in 1864. On June 23 he instituted a direct comparison between the spectrum of the comet and that of carbon. The bands were found not only to agree in position, but in relative brightness and general appearance. The lines due to the hydrogen of the olefiant gas were not seen in the spectrum of the comet. On June 25, Mr. Huggins repeated his observations with the same result.

These observations are the first which have given *exact* information respecting the substance of a comet. The other comets which have been subjected to spectroscopic analysis have presented spectra which indicate the general character of the comet's substance, but not one of the spectra has corresponded exactly with the spectrum of any of the terrestrial elements.

It seems difficult to understand how it is that carbon can be volatilised in the interplanetary spaces; but we do not as yet know enough respecting the conditions under which substances circumstanced as cometary matter is emit light, to enable us properly to estimate this difficulty. Certainly some comets have approached near enough to the sun to be subjected to an intensity of heat sufficient to account even for the volatilisation of such a substance as carbon.

The Great Total Solar Eclipse.—We have now received intelligence from four of the observing parties. Dr. Janssen, who headed the French expe-

dition, has been able to observe the spectrum of the coloured prominences. These objects are gaseous. The spectrum is remarkable, but we have yet to learn what its exact character is. Lieut. Herschel, who appears to have observed the eclipse under somewhat less favourable circumstances, sends confirmatory evidence. He found no trace of lines in the spectrum of the corona. The polarisation of the corona is solar.

Major Tennant states that the sky was covered with light fleecy clouds during the totality, but that the eclipse was on the whole successfully observed. As the party he headed set out with the special object of obtaining photographic views of the progress of the eclipse, we may fairly assume that several such views have been successfully taken. We understand that the Newtonian reflector, specially prepared for this purpose by Mr. Browning, the optician, received some injury in the journey out. Fortunately, it would seem that this accident, whatever it was, has not sufficed to affect that delicacy of definition which is absolutely required in a telescope constructed for the processes of solar photography.

It will be interesting to compare the views obtained by Major Tennant with those which have been taken by the Prussian party at Aden. Never before have astronomers had an opportunity of comparing photographs of the red prominences taken at times separated by so long an interval as an hour. During the eclipse of 1860 Father Secchi and M. de la Rue severally obtained photographs of the sun at times separated by ten minutes. In that instance the figures of the red prominences were found to have undergone no change whatever during the interval. The news from the Prussian party states that they have obtained six photographs, of which two only have been slightly injured by the passage of streaky clouds over the prominences.

Suspected Change in the Latitude of the Greenwich Observatory.—In a careful investigation of many years' observations of the stars *Polaris*, *α Cephei*, and *δ Ursa Minoris*, Mr. Stone of the Greenwich Observatory has noticed a periodic variation, which appears to depend upon the position of the moon's node. He remarks, that "if this evidence be considered sufficient to indicate an apparent periodical change in the co-latitude of the Greenwich Observatory, it may perhaps be taken as a proof of the yielding of the earth's crust under the moon's action, or referred to a systematic deformation of the atmosphere arising from the same cause. Very slight changes in the inclination of the general direction of the effective strata of the atmosphere would be sufficient to produce in the co-latitude apparent variations of the required amount." It may be noticed that a somewhat similar anomaly appeared in the results of the Rev. R. Main's attempts to determine the annual parallax of γ Draconis. The effect of this was that the annual parallax came out a *negative* quantity! This, of course, if referred to the effects of a systematic deformation of the atmosphere, would indicate one having an *annual* period.

The Nebula round η Argûs.—In a paper communicated to the Royal Astronomical Society, Sir John Herschel deals with the changes recorded by Mr. Abbott, to which we referred in our summary for July. He considers the changes so very remarkable, that the attention of every observer in the southern hemisphere, provided with instruments at all competent to

show the principal details of the nebula, should be directed to its delineation. "There is no phenomenon in nebulous or sidereal astronomy that has yet turned up," says Sir J. Herschel, "which presents anything like the interest of this, or is calculated to raise so many and such momentous points for inquiry and speculation." The whole nebula would seem to have changed in form and character, and not only so, but the fixed stars which are presented in the same field would appear, if Mr. Abbott's views can be trusted, to have "bodily fled away and given place to a new set." Not less remarkable is the great increase which would seem to have taken place in the brilliancy of the nebula. And in the midst of these phenomena, which we are compelled to look on for the present as more or less doubtful, there is the admitted fact that the strange variable η Argûs itself (round which the nebula clings)—which was shining a few years ago with a brilliancy rivalling that of Sirius—is now reduced to the sixth magnitude; in other words, is just perceptible with the naked eye on a very dark night.

Penumbral Lunar Eclipses.—Solar eclipses, in which the earth passes within the moon's penumbra, are noticed in the *Nautical Almanac* as "partial solar eclipses." But the corresponding class of lunar eclipses—that is, eclipses during which the moon passes within the earth's penumbra, but does not touch the umbra—are not recorded in astronomical ephemerides. In a paper communicated to the Royal Astronomical Society, Mr. Proctor has noticed this omission, and he gives the elements of an eclipse of this sort which (according to his calculation) must have occurred on the morning of Sept. 2. We do not hear that any observer has witnessed this phenomenon. Eclipses of this sort might have some value to the spectroscopist.

Jupiter and Mars.—Jupiter is now very favourably situated for observation. Mars is gradually becoming more favourably situated. He has now a great northerly declination; and although he is nearly at his greatest distance from the sun, he will probably be subjected to careful scrutiny during the next few months. We understand that Mr. Browning proposes to observe the planet systematically with his fine 12-inch reflector; and we hope for valuable and interesting views of the planet's northern hemisphere, hitherto very insufficiently observed, on account of the unfavourable circumstances under which Mars is seen when his northern hemisphere is turned towards the earth.

The Lunar Crater Linné.—Professor Respighi, in a letter to the Padre Secchi, published in the *Bullettino Meteorologico* of Rome for May 31, presents his reasons for arriving at the definite conclusion that the crater Linné is not subject to variations of figure. Our best observers still continue to be divided in opinion respecting this remarkable object. Whatever opinion may eventually prevail, the announcement of a lunar volcano in eruption, which was so confidently made a few months ago, has not been without profitable results, as it has called the attention of astronomers to the difficulty and value of selenographical delineation.

The 99th, 100th, and 101st Asteroids have been discovered—the first at the Marseilles Observatory; the second by Mr. Watson, of Detroit, Michigan; and the third by Dr. Peters, of the Observatory connected with Hamilton College, New York. On August 24, at 3 A.M., the last-named was in Pisces, R.A. 18° 38′, and N. Dec. 19° 54′. During the past twenty-three years no

less than ninety-seven of these bodies have been discovered; or, on an average, upwards of four per annum.

A new Driving-clock for Equatorials.—Mr. Cooke has been successful in devising a driving-clock in which the regulator is the ordinary vibrating pendulum. The difficulty in this case is to convert the jerking or intermittent motion produced by vibrating pendula into an uniform motion, which can be available with little or no disturbing influence on the pendulum itself, when the machine is subject to the varying frictions and forces which have to be overcome in driving large equatorials. This difficulty Mr. Cooke appears to have successfully overcome. He states that "the uniform rotatory motion obtained by a clock constructed on his plan appears to be perfectly satisfactory, so far as experiments can be made by applying widely different weights and comparing the times with a chronometer." As there is no other means at the mechanician's command for obtaining good time-keeping, which is so accurate as the vibrating pendulum, it is important that this means should have been rendered available to the astronomical observer.

The approaching Transit of Mercury.—On the morning of November 5 the sun will rise with Mercury on his disc. The transit of the planet will end two hours after sunrise.

The November Shooting-stars are not likely to be favourably seen this year in England; in fact, we need hardly expect to see them again until the year 1870. Even then the display is not likely to be very brilliant, as the part of the system through which the earth will then pass will be much less densely strewn with meteoric bodies than the part passed through in 1866. The epoch of maximum display this year is likely to occur during midday in England and in most parts of Europe.

Sun-spot visible to the naked Eye.—An enormous sun-spot was distinctly visible to the naked eye on August 14. We are not aware that any European observers noticed the circumstance; but the owner of Fern Lodge Observatory, Palisades, Rockland, county New York, who has supplied an interesting picture of the spot, announces that it could be clearly seen with the naked eye.

Fall of Meteorolites in Piedmont.—A somewhat remarkable fall of meteorolites is recorded, in *Comptes Rendus* for August 3, as having taken place in Piedmont on February 29, 1868. Several large masses of meteoric matter would seem to have burst, the fragments falling over an extensive area. On analysis the fragments were found to contain silica, sulphur, phosphorus, copper, metallic iron, oxide of iron, nickel, manganese, chromium of iron, alumina, magnesia, potash, lime, and soda.

BOTANY.

The Tendrils of the Cucurbitaceæ.—Those who are interested in what used to be styled vegetable morphology should read an excellent memoir by M. Lestiboudois, "On the Homologies of the Tendrils of the Cucurbitaceæ." This botanist lays down the proposition that the tendrils in their order are modified leaves, and the evidence he adduces in support of it relates both to the

external conformation and the internal structure of the organ. The paper is too long for abstract, but it seems that M. Lestiboudois makes out a good case. The illustrative examples are numerous and appropriate. The following conclusion terminates the memoir:—The bundles (woody bundles?) in many of the cucurbitaceæ have the peculiar arrangement of foliar expansions; these divisions are strikingly like the disposition of the veins of palmate leaves. These characters undergo modifications, but they are never as great as those seen in the petiole itself. Hence it seems right to conclude that the tendril represents a leaf produced by an axillary branch. Vide *Comptes Rendus*, August 10.

Mycoderma Cervisiæ.—In an important paper on the development of the yeast of beer, M. Trécul publishes some very interesting facts concerning the relation which exists between apparently different species of the lower fungi. M. Trécul concludes that there is a specific identity between the yeast of beer and the *Mycoderma cervisiæ.* It appears to him most likely that the yeast of beer invariably commences its existence by cells of this mycoderma. In the same number of the *Comptes Rendus* (August 10) in which this paper of M. Trécul is published there is also a communication from M. Pouchet. The advocate of Heterogeny claims the priority of the observations reported above. He states that M. Trécul has fully confirmed all that he has already published in his work on spontaneous generation. He, however, differs from M. Trécul in reference to the statement made by the latter, to the effect that the yeast rapidly spreads by budding. This phenomenon M. Pouchet denies. He states that one is very easily deceived in regard to it, and that he had made hundreds of experiments before he was able to demonstrate that the process does not take place.

The Ripening and Reaping of Grain.—The question when corn ought to be cut so as to secure the heaviest and best grain is one of great importance both to the agriculturist and the country. The following quotation from a French Journal is therefore of some interest:—"Certain agronomists are of opinion that there is a great advantage in reaping corn before its complete maturity, when the grain is still in a milky state, because then it is more yellow, larger, and heavier, and does not so easily fall out of the ear during harvest operations; moreover, the straw is then better for cattle. M. Isidore Pierre, professor of chemistry at Caen, has endeavoured to ascertain by direct experiment whether there was any sufficient foundation for this belief. He accordingly cut from the same field a certain quantity of ears on the 6th, 11th, 15th, 20th, and 25th of July, each time operating on equal surfaces of ground. The grain gathered on the 6th was in a state of rapid increase, while that of the 25th was perfectly ripe, and in course of reaping that very day. The result was, that in a state of perfect dryness the first lot was to the second as 15 to 27, the other lots being, of course, intermediate between the two. Taking the hectare as the unit of surface, M. Isidore Pierre arrives at this conclusion: that, during the three weeks preceding the harvest, a crop of wheat will experience an average daily increase of one hectolitre, the weight of the latter being 81 kilog. Hence, for every day corn is reaped earlier than the full period of maturity, there is a loss represented by a 20-franc piece or thereabouts per hectare. Chemically considered, the grain that has not arrived at full maturity contains less

nitrogen and more phosphoric acid than when ripe; that is, it will be poorer in amylaceous matter and in gluten. It may therefore be admitted that if, as indeed is the case, a certain loss is experienced by the falling out of the grain from the ears in reaping corn arrived at maturity, this is amply compensated by an increase of weight and nutritious matter."

Mr. Darwin's recent Researches.—Mr. Darwin has sent us two pamphlets, reprints from the *Linnæan Society's Journal*, which show that he is continually adding to the vast store of botanical facts recorded in his work on *Animals and Plants under Domestication.* These memoirs are of too great length, and embrace too many important details, to admit of our giving a satisfactory abstract of them here. We therefore briefly record some of the conclusions of their author, and refer our readers to the *Linnæan Society's Journal* (Botany, vol. x.) for further information. In one of the papers—"On the specific Difference between *Primula veris, P. vulgaris*, and *P. elatior*, and on the hybrid Nature of the common Oxlip"—Mr. Darwin proves, as we think satisfactorily, that the three first forms are specifically distinct, and that the oxlip is merely a hybrid. The results of the different "crossing" experiments are so lucidly tabulated, that the evidence in favour of the author's opinion may be seen at a glance. Mr. Darwin regards the oxlip as a hybrid between the cowslip (*P. veris*, Brit. Fl.) and the primrose (*P. vulgaris*, Brit. Fl.), as has been surmised by various botanists. He thinks it probable that the oxlips may be produced either from the cowslip or the primrose as seed-bearer, but oftenest from the latter, as he judges from the nature of the stations in which oxlips are generally found, and from the primrose, when crossed by the cowslip, being more fertile than the cowslip by the primrose. Mr. Darwin also demonstrates the specificity of *Primula elatior*. The title of Mr. Darwin's second memoir is sufficient to indicate the mass of valuable facts the paper contains, and the painstaking and laborious inquiries which have been undertaken by the author. It is "On the Character and hybrid-like Nature of the Offspring from the illegitimate Unions of dimorphic and trimorphic Plants." The plants dealt with here are *Lythrum Salicaria, Oxalis rosea, Primula sinensis, P. auricula, P. vulgaris, P. veris*, and *Pulmonaria.* The general conclusion which the author draws is one of the highest interest, for it in part solves one of the most serious objections (that of the sterility of species) raised against the theory of the origin of species by natural selection. This conclusion is partially expressed in saying that *the illegitimate offspring from an illegitimate union are hybrids formed within the limits of one and the same species.* In proof of the importance of recognising the infertility existing between certain sexual forms of dimorphic and trimorphic plants, Mr. Darwin says:—"If any one were to cross two varieties of the same form of *Lythrum* or *Primula*, for the sake of ascertaining whether they were specifically distinct, and he found that they and their offspring were extremely sterile, and that they resembled in a whole series of relations crossed species and their hybrid offspring, he would maintain that his varieties had been proved to be good and true species; *but he would be completely deceived.*"

A new Disease of the Vine.—In a memoir presented to the French Academy of Sciences, on August 3, M. Bazille calls attention to a new disease which has attacked the vine in many of the French provinces, and which appears likely to prove more destructive to the crop than even the famous *oïdium*

parasite. The malady is rapidly contagious, and has been discovered to be parasitic, the parasites being a species of aphis, very different from the common type of this group of insects. When the roots of an affected vine are examined even with the naked eye masses of yellowish corpuscles may be distinctly seen. When magnified these are seen to consist of clusters of insects in every degree of development, from the ovum to the adult. They differ from the common *aphis* (*A. rosæ*?) by the absence of the honey-secreting organs, by the form of the body, by the antennæ being inserted lower into the thorax, and, finally, by the fact of their being oviparous all through the year. They are allied to the genus *Rhizobius*.

The Morphology of Eupomatia.—This subject, which has attracted the attention of botanists since the time of Robert Brown, has been taken up by M. H. Baillon, who has published a short note upon it. He states that the flowers of this plant enclose in their concave receptacle a true polycarpal gynœcium; what has been described as a simple areolated stigma is in reality a portion of the dorsal wall of the ovaries. The stigmata are independent of each other, and are of the same number as the carpels. The other details are of equal interest to the student of vegetable physiology. Vide *Comptes Rendus*, July 27.

A new organographical Character, which is expressed as the inclusion of the style in a matrix formed from the corolla, has been described in a paper read before the *Académie des Sciences* (July 20) by M. Ed. Gouriet. The author thus puts his facts forward:—"When we examine a flower well in blossom of *Justicia nodosa* (Hooker), the two lips of the corolla being as separated as possible, we see on the arch of the upper lip and near its free extremity two anthers supported by long filaments; between the anthers and a little above them we distinguish a filiform stigma, well seen in profile, but we do not at first sight perceive the style which ought to connect this organ with the ovaries. If, after having detached the lower lip and the corresponding part of the tube of the corolla, we hold the upper lip in one hand, and isolate the stigma with the other, we may then perceive the style, which is nearly as long as the flower (about 6 centimetres), and which seems to detach itself readily from the corolla as the latter is torn back. On looking a little closer we may see that the union between the two is only apparent, but on the face of the corolla we may distinguish a long grooved canal, whose borders, by a very slight union, form a complete sheath enveloping the style." M. Gouriet has examined flowers in the bud, in full bloom, and in all intermediate stages, and he has invariably found this invagination of the style by the corolla. He also states that the character cannot be abnormal, for he has found it in all the specimens examined by him this year and last year. Having found no allusion to this structure either in the *Prodromus* or in Curtis's *Botanical Magazine*, in which there is a detailed description of Justicia, he regards it as new to botanists. Hence he proposes to call the canal a *coleostyle*, and to speak of corollæ with this character as *coleostylated.**

Lotus esculentis.—According to M. T. Desmartis the galls (*galles*) of this

* In reference to the novelty of this discovery, we may mention that in the *Treasury of Botany*, Mr. Carruthers describes the corolla of Justicia as being provided with a long tube: is this the tube in question?—Ed. P. S. R.

plant are most valuable in cookery. They give a flavour and perfume identical with the best truffles of Perigord. Hence he names the Lotus, *Lotus truffier*.

The Antherozoids of Mosses.—M. E. Roze, in a note addressed to the Academy, gives the results of his later observations on these structures. The results of his first researches led him to conclude that the fecundating organs were constituted by a single biciliated filament with two spiral turns, to which were attached, but only during the motility of the filament, a mass of starchy granules. He has this Spring, with the assistance of Hartnack's immersion objective No. 15, been able to demonstrate that these granules, instead of being fixed upon the ciliated spire, are enclosed in a plasmic hyaline vesicle, which is attached to the special filament by a sort of tangential adhesion. Under a power of 1,500 diameters the vesicle shows itself very distinct by its spheroidal outline and by the very active molecular movement of the granules. Like the plasmic vesicle of the antherozoids of other classes of Cryptogamia, the vesicle is inflated with water soon after the filament ceases to move; then it bursts and sets free the starchy granules to continue their rapid molecular movements, which seem invariably to coincide with the cessation of movement of the spiral filament. M. Roze states that the new lens has only confirmed the conclusions he has already published on this subject. Vide *Comptes Rendus*, June 15.

Specific Identity of the Almond and Peach.—A paper on this subject was read before the British Association at the Norwich meeting by Dr. Karl Koch. The author said it had long been a debated question as to whether the peach tree was descended from the almond; but a careful examination of the subject had convinced him that the almond was the original stem from which the peach was derived. He referred to the cultivated plum trees, and said that in his opinion the greengage was descended from a different stem to that from which the ordinary plum and damson were derived. All cultivated cherry trees were, he thought, descended from one parent stem. Dr. Koch also suggested in another paper the advisability of photographing plants for the purposes of identification.

Rate of Growth of Wellingtonia.—At the same meeting Mr. John Hogg, F.R.S., read a paper on the Wellingtonia Gigantea, with remarks on its form and rate of growth as compared with the Cedrus Libani. The author alluded to some of the peculiarities of this remarkable tree, a magnificent specimen of the bark of which was exhibited in the tropical department of the Crystal Palace, now unfortunately destroyed. Several groves of these monarchs of the forest were described, containing in all about 1,250 trees. The author did not agree in the estimate of the age of one of these mammoth trees, which had been said to be 3,000 years old; believing its real age to be about 1,300 years. The value of the timber of a single tree, at a halfpenny per foot, was stated to be 6,250*l*. The author had one of these trees (eight years old, and 7 feet 6 inches high) in his own possession. It bore two cones and one male flower at the age of six years; the cedar of Lebanon not bearing cones till after the age of twenty years.

CHEMISTRY.

The Rate at which chemical Actions take place.—Mr. Vernon Harcourt recently delivered a lecture before the Royal Institution, in which he discussed this very important problem in Chemical Physics. The following propositions embrace the conclusions arrived at from the examination of cases of gradual chemical change:—1. The rate at which a chemical change proceeds is constant under constant conditions, and is independent of the time that has elapsed since the change commenced. 2. When any substance is undergoing a chemical change, of which no condition varies, excepting the diminution of the changing substance, the amount of change occurring at any moment is directly proportional to the quantity of the substance. 3. When two or more substances act upon one another, the amount of action at any moment is directly proportional to the quantity of each of the substances. 4. When the rate of any chemical change is affected by the presence of a substance which itself takes no part in the change, the acceleration or retardation produced is directly proportional to the quantity of the substance. 5. The relation between the rate of a chemical change occurring in a solution, and the temperature of the solution, is such, that for every additional degree the number expressing the rate is to be multiplied by a constant quantity.

The Detection of Nitroglycerine in cases of poisoning is a matter of some chemical interest. The method which has been recommended by Herr Werber is as follows:—The organic material to be tested is extracted with ether or chloroform, the extract mixed on a watch glass, with two or three drops of pure aniline, and evaporated upon the water-bath. A few drops of concentrated sulphuric acid are then added, when, if nitroglycerine is present, a purple coloration appears which changes to a dark green on dilution with water. As little as ·001 grain of nitroglycerine may thus be identified.—Vide *Zeitschr. Analyt. Chem.*, vii. 158.

What is Iodide of Starch?—This question receives an answer in the recent enquiries of M. Guichard. M. Guichard thought that an examination with the dialyser would throw light upon the question. If there existed, in fact, a combination of iodine and starch, the compound ought to be colloidal, and remain in the dialyser; if, on the contrary, only dissolved iodine and hydriodic acid were there, starch would alone remain. M. Guichard made a great number of experiments, and he remarked that iodine passed the dialyser first, then hydriodic acid in large quantity, afterwards the iodide became suddenly decolorised, and later the iodine, as well as the hydriodic acid, ceased to be disengaged. When the experiment was made with iodide of starch decolorised by heat, the disengagement of iodine was difficult to perceive, that of hydriodic acid was alone observed; the same was the case with the iodide heated in close vessels for some hours to 100°, then to 150°. The colourless iodide of starch has then no existence; the so-called iodide of starch is simply starch tinted by iodine. Heat thus separates the iodine from the starch; the iodine then remains in the water, either as such or as hydriodic acid.

How to bleach Palm Oil.—This is a practical point of considerable importance

to the manufacturer. The following method, which has been given by Herr Engelhardt in *Dingler's Polytechnisches Journal*, is therefore of interest:—A given quantity of palm oil is placed in an iron pot, heated to about 62° C., and allowed to stand all night. The next day it is poured into a clean vessel and cooled to 40° or 37° C. Meanwhile a certain quantity of water, say for instance 45 kilogrammes of water to 1,000 of palm oil, is set to boil; in it are dissolved 15 kilogrammes of bichromate of potash, and when the solution has cooled a little, 60 kilogrammes of chlorhydric acid are added. This mixture is then poured into the palm oil, which must be quickly stirred, and in about five minutes it will assume a sombre green colour from the reducing action of the combination of the chromate with the chlorhydric acid. By continuing to stir, the separation of the oxide of chromium is completed, and the oil gradually clarifies and becomes at last quite limpid. In order to render it quite white it is now only necessary to wash it in warm water; if, however, it should not appear quite colourless, the operation must be repeated with 0·25 kilogrammes of red chromate and 1 kilogramme of chlorhydric acid. This method is quick, free from danger, and produces very good results. The author declares that the new methods in which either gaseous chlorine, chloride of lime, or a mixture of chlorhydric acid with peroxide of manganese are proposed, are much inferior to the above process.

Some Experiments on chemical Filters.—In a paper published in a recent number of the *American Journal of Pharmacy*, Mr. Charles E. Avery records some very interesting experiments which he conducted on filters, in order to determine how to obtain the greatest rapidity of efficient filtration. We give his own words. After describing some preliminary observations, he says, "it occurred to me to fold the plain qualitative filter in two operations instead of one. In place of folding the filter doubled upon itself down the middle in the usual way, I proposed to turn down on each side of the paper a fold equal to one-quarter of the semicircle, and then to fold the sections of 45° arc thus formed back upon themselves. The filter is then opened without disturbing the folded portions, and placed upon the funnel. In this form the triple side of the plain filter is broken up, and the folded portions keep open passages, instead of hindering filtration. This filter, as tried against the plain form, gave, 1st, 133 : 100. 2nd, 111 + : 100. 3rd, 205 + : 100. Two plain filters ran equally in several trials; each was changed into the other's funnel, and No. 1 ran 33 per cent. less than No. 2. No. 1 was dried and folded into my form; remaining in the same funnel, it ran 32 per cent. faster than the other. Both filters were then opened, and showed no tear or weakness when held against the light. As these filters gave different results in different funnels, I thought I would ascertain the cause. The water seemed to be retarded in its passage by the attraction of the glass; therefore, those funnels having the greater portion of the paper free from the glass would be the best; that is, ***a broad-throated funnel, other things being equal, will filter faster than a narrow-throated funnel.*** To test this point I selected two *large* funnels; No. 1 had three times as broad a throat as No. 2. With the first filters they ran, 117 : 100. 123 : 100. 133 : 100. 118 : 100. The reason for this low difference was found in a thin spot near the point of No. 2. Other sets of filters gave—2nd set,

292 : 100. 318 : 100. 3rd set, 288 : 100. 335 : 100. 4th set, 300 : 100, burst. 5th set, 384 : 100. 407 : 100. 482 : 100. 6th set, 242 : 100."

A new Process for the Manufacture of white Lead has recently been devised by M. A. Girard :—The lead is first prepared for treatment by granulating it; the granulated metal is placed in a rotating cask (which should be made of beech or elm, not oak) with one-fourth its weight of pure water. The cask is made to rotate at the rate of thirty or forty turns a minute, and arrangements are made for the passage of a current of air during the rotation. After about two hours, nearly the whole of the lead is found to be oxidised, and then carbonic acid is introduced in the place of the current of air, and the rotation continued for four or five hours further. At the end of this time nearly the whole of the lead is found to be converted into hydrated carbonate, fine white lead, which can be separated from all the metal remaining intact by decantation.—Vide *Chemical News*, July 3.

Impure Sulphate of Ammonia.—At the Norwich meeting of the British Association, Dr. T. L. Phipson read a paper on Sulphocyanide of Ammonium, in which he pointed out a fact of some importance to agriculturists. Dr. Phipson stated that for many years past the ordinary sulphate of ammonia manufactured in gas works by neutralising gas liquor with sulphuric acid contained small quantities of sulphocyanide of ammonium, say from 2 to 4 per cent.; but latterly many specimens of commercial sulphate of ammonia contained a very much larger proportion, some specimens yielding as much as even 75 per cent. of sulphocyanide. So that, in fact, the article might rather be named impure sulphocyanide of ammonium than sulphate of ammonia. The knowledge of this fact is of great importance to makers of chemical manures and farmers, inasmuch as only one-half of the nitrogen existing in sulphocyanide can be made available for manuring purposes.

The Acetification of Alcohol.—It has been frequently found by vinegar makers, says the *Chemical News*, that the acetification of alcohol in the casks does not proceed uniformly, and that on this account the strength of the acid manufactured varies considerably. To facilitate oxidation, M. Artus dissolves 15 grammes of dry chloride of platinum in 2·5 kilogrammes of alcohol, and in the solution places 1·5 kilogramme of wood charcoal in pieces of the size of a nut; he then calcines in a covered crucible. This done, he takes 0·75 kilogramme of platinised carbon, and strews it upon a wooden cover pierced with holes, placed over the open top of a vinegar cask, 2 metres in height and of from 0·80 m. to 0·90 m. in diameter; the vinegar is not allowed to moisten directly the cover with the platinised carbon. After five weeks' work, the platinised carbon is calcined afresh. The action of this carbon is very remarkable, the acetification is effected more rapidly and completely than in operating in the ordinary way, and the vinegar possesses a more agreeable flavour.—Vide *Chemical News*, June 19.

A black aniline Varnish, which promises to be of some commercial value, is now being produced in France. The following is the mode of preparation:—In a litre of alcohol 12 grammes of aniline blue, 3 grammes of fuchsine, and 8 grammes of naphthaline yellow are dissolved. The whole is dissolved by agitation in less than twelve hours. One application renders a white object ebony black; the varnish can be filtered, and will never

deposit afterwards. The three colours are not destroyed, for each can be separated by analysis with the characteristic properties.

Action of Sulphurous Acid on silver Compounds.—In a communication to the *Chemical News* (Aug. 21) Professor J. S. Stas gives an account of his recent observations on this subject:—A current of sulphurous anhydride, prepared by means of the combustion of sulphur in dry air, or by the decomposition of sulphuric acid by copper, mercury, carbon, or wood, produces a *white* precipitate of sulphite of silver in an aqueous solution of nitrate or sulphate of silver; the liquid remains colourless. A solution of sulphurous acid, newly obtained by passing the anhydride through boiled water, and *protected from the action of the light*, behaves like the anhydride. The sulphite of silver produced, kept from the light, seems to him to keep indefinitely at common temperatures; but under the influence of light, or of an excess of sulphurous acid, it changes into a mixture of sulphate of silver and metallic silver. A current of sulphurous anhydride, or a fresh saturated aqueous solution of this anhydride, does not precipitate sulphite of silver from a solution of nitrate or sulphate of silver, dissolved in water acidulated by a sufficient quantity of sulphuric or nitric acid; *the liquid remains colourless.* In *complete darkness*, the liquid may even be kept for a long time at 100° C., without the slightest precipitate or change of colour. A solution of sulphurous acid in pure water, whether boiled or not, after being left for some time in the light, gives a *grey* precipitate with sulphate and nitrate of silver; in a few moments the supernatant liquid becomes successively yellow, brown, and black, and at length throws down sulphide of silver. He has seen such a solution of altered sulphurous acid precipitate, in darkness, metallic silver from a solution of nitrate or sulphate of silver in dilute sulphuric acid, and even in dilute nitric acid.

A new ammoniated Chloride of Zinc.—In the course of some recent researches on a new class of zinc compounds Dr. Edward Divers succeeded in discovering a pentammoniated chloride of zinc. This discovery is of no inconsiderable importance since it adds another to the three zinc chlorides already described by Sir Robert Kane. The following is the process by which the new compound is obtained:—Solid zinc chloride is dissolved in the strong solution of ammonia of commerce, and as the solution of the first portions of chloride is attended with a marked rise of temperature, it is advisable to add the salt gradually, to close the vessel tightly to prevent expulsion of the ammonia, and to cool the vessel by a stream of cold water. When the solution of the zinc chloride becomes exceedingly slow, ammonia gas is passed into the liquid. If this is kept cool a crystalline precipitate soon forms; if, on the contrary, the liquid is not kept cool by the application of external cold, the liquid usually remains clear for some time. When the liquid in the cold state contains a moderate amount of deposit, the passage of ammonia into it must be stopped; then on closing the vessel containing it, and heating gently and shaking, the crystalline deposit may be redissolved. On cooling, the solution gradually yields the new chloride in large crystals of remarkable appearance. They are regular octohedra, with perfect angles and edges, but with deficient faces; that is to say, the faces are hollowed out in a series of steps from the edges to the centre of the face, so as to exhibit a structure similar to that seen in the hollow pyramidal

crystallisations of sodic chloride. The mode in which such crystallisations of sodic chloride are produced is well known to be the formation of a small cube of the salt at the surface of the brine, to which it adheres by one of its faces, causing a depression in the fluid surface because of its density, and then the gradual addition to the upper external edges of the crystallisation of successive square courses of the sodic chloride. The formation of the hollow faces of the octohedra of the new ammoniated chloride of zinc is apparently partly similar to this—comparatively large crystals sometimes hanging from the surface of the mother liquor by a hollow face. But then all the faces of these octohedra are thus hollowed out so that their formation can have no necessary connection with crystallisation at the surface of the fluid; and to make the crystals of sodic chloride similar in their hollowed form to these octohedra, the cubical piece at the apex of the pyramid would have to be the centre and common apex of six such pyramids united in the form of a cubical flock with hollowed faces.

The Coloration of Peroxide of Nitrogen.—A very interesting note on this subject by M. Salet appears in the *Comptes Rendus*, Aug. 24. The author endeavours to explain the curious relation which exists between the diminution of density and increase of coloration.

Volumetric estimation of Zinc.—In a paper presented to the French Academy (Aug. 17) M. A. Renard gives an account of his process for the above purpose. If, he says, to a determined solution of yellow prussiate of potash you add a solution of a salt of zinc, the zinc is wholly precipitated in the form of a double ferrocyanide of zinc and iron, completely insoluble in ammonia. By determining with potassic permanganate the excess of prussiate of potash employed you obtain by easy calculation the quantity of zinc.

Chlorosulphuric Ether.—M. Th. de Purgold describes this substance, which is procured by directing the vapour of chlorhydric ether through anhydrous sulphuric acid. This peculiar compound has the following formula: $C_2H_5ClSO_3$.

Persulphide of Hydrogen.—The last number of the Proceedings of the Royal Society (No. 103) contains a paper by Dr. Hofmann, on the constitution of this remarkable body. The views of chemists being known to differ remarkably in reference to the chemical composition of this substance, Dr. Hofmann was led to examine carefully a compound which he accidentally discovered, and which appears to throw some light on this subject. On adding a cold saturated solution of strychnine in strong alcohol to an alcoholic solution of polysulphide of ammonium, brilliant crystalline spangles soon appear, and after twelve hours the walls of the vessel are covered with beautiful orange-red needles often a centimetre long, and which have only to be washed in cold alcohol to render them perfectly pure. Analysis of them has led to the formula:—$C_{21}H_{22}N_2O_2$, H_2S_3. Hence Dr. Hofmann concludes that the crystals are a compound of one molecule of strychnine and one of persulphide of hydrogen of the composition H_2S_3. That this is really the constitution of the compound is proved by the fact that in contact with concentrated sulphuric acid the crystals are decolorised and an addition of a small quantity of water, colourless transparent oily drops of persulphide of hydrogen are separated, sulphate of strychnine

remaining in solution. The oil drops are ultimately decomposed into sulphur and sulphuretted hydrogen. In making similar experiments with quinine, brucine, and other bases, no such results were observed.

GEOLOGY AND PALÆONTOLOGY.

The Influence of the Gulf-stream.—There is no more general subject of conversation among Englishmen than that of climate, and there are few more popular scientific explanations of our meteorology than that involved in a vague reference to the Gulf-stream. Everyone will tell you of the influence of the Gulf-stream, and yet very few, we are convinced, have any idea of the extent or character of the influence of this vast body of water. We would therefore advise all who are anxious to inform themselves on this point to consult the paper by Mr. Henry Woodward, F.G.S. (the editor), in the *Geological Magazine* for July. In this communication Mr. Woodward has put together the ideas of all those who have given serious attention to the subject, and he has as a result produced a paper which is most suggestive from a geological aspect, and most instructive and interesting from a general point of view.

Bos primigenius in the Lower Boulder-clay of Scotland.—This interesting discovery is announced by Mr. James Geikie. Mr. Geikie had heard from the navvies on the Crofthead and Kilmarnock Extension Railway that they had come across a "wonderful big bull's head," and on visiting the spot found that the specimen was the skull of *Bos primigenius.* The skull is in rather an imperfect state and only one of the horn-cores remains, the other having been broken off near the base. The perfect core measures 31 inches along the outer curve, and gives at its base a circumference of 14 inches. The breadth of the forehead between the horns is 10 inches. From the character of the flat forehead, from the origin of the cores, and from the direction and curvature of the remaining one, Mr. Geikie thinks there can be no doubt of the species described. The specimen was embedded some few feet deep in soft mud or clay, interlaminated with lines and beds of sand, and occasionally layers of fine gravel. There were remains of some plant in the clay, but they were in too imperfect a state of preservation to enable Mr. Geikie to come to any conclusion as to their nature. The paper in which Mr. Geikie records his discovery is accompanied by a number of sections showing the relations of the beds to the boulder-clay.—Vide *Geological Magazine,* September.

Greensand Brachiopoda.—Mr. J. F. Walker has published an account of the Brachiopoda found by him in the Lower Greensand at Upware. He describes some new species, and gives a very useful tabular scheme of the distribution of Brachiopoda in the Lower Greensand of this country.—Ibid.

M. Brongniart on Fossil Lycopodiaceæ.—M. Brongniart has been working recently at this subject, and has had the opportunity of examining quite a new and perfect form of the *Triplosporites* of Robert Brown. The specimen, which was perfectly silicified, was divided with a fine saw, and displays all the organisation in the most perfect manner. It presents itself under the

form of a cone or cylindrical strobilus ·12 metre long and ·055 metre wide; it shows externally the summits of scales which form 27 perfectly regular longitudinal rows, disposed in spiral order represented by the fraction $\frac{2}{27}$, a disposition not unlike that of many living Lycopodiaceæ. The further details of M. Brongniart's paper are too numerous for further abstract. The paper may be read in the *Comptes Rendus*, August 17.

A new Classification of Echinidæ.—M. A. Pomel, who has been for some time preparing a comprehensive memoir on the fossil Echinoderms of Western Algeria, has prior to its publication submitted his new classification of Echinidæ to the consideration of the *Académie des Sciences* (Aug. 3). The Echinidæ, he says, present three types, which progress regularly from the bilateral (*symétrie paire*) to the radiate symmetry, and form three groups, to which he has given the name of *Spatiform, Lampadiform* and *Globiform.* The first have the mouth placed very excentrically in front, and the anus lies posteriorly; the obliteration of the anterior ambulacrum and the obovate form mask the radial symmetry to the advantage of the bilateral. The second have the mouth central, or very nearly so, and the anus less or more posterior, but close enough to the genital parts to enter into that series. The third have the mouth central and the anus opposite and included in the genital apparatus. The *Spatiform* or Spatangoid Echini form two groups: (1) *Ananchytæ* where the ambulacra are throughout represented by simple pores. (2) *Spatangæ,* where the ambulacra are petaloid. The Lampadiformæ are grouped into dentate and edentate. Lastly, the Globiformæ include the Cidaridæ and Echinidæ. The other divisions of M. Pomel's scheme will be found in the paper already referred to.

Précis élémentaire de Géologie.—The eighth edition of this treatise, by M. d'Omalius d'Halloy, has been published.

The Constitution of the Interior of the Globe.—Few questions possess greater interest for the geologist than this one of the internal constitution of the globe. Few too display greater discrepancy of opinion in the history of the science. Many years ago Mr. Hopkins adopted an astronomico-mathematical argument to show that the facts of *precession* and *nutation* were incompatible with the theory that the globe was a liquid mass, enclosed in a thin solid crust. His views have since been very largely accepted. But they have now met with a formidable opponent in M. Delaunay, one of the foremost mathematicians and astronomers in France. In a memoir—which we wish we had space to translate in full—M. Delaunay goes at length into Mr. Hopkins and Archdeacon Pratt's arguments and arrives at the provisional conclusion that the astronomical evidence adduced tells as much on one side as on the other, and that in point of fact the problem is now as unsolved as when it first presented itself to men's minds. This expression of opinion on M. Delaunay's part must have great weight with geologists.—Vide *Comptes Rendus*, July 13.

The Chalk of Antrim.—Mr. J. Beete Jukes, of the Irish Geological Survey, states that the upper surface of the Antrim chalk is covered with a layer of flint gravel, from one to six feet thick, and over this lie thick ranges of columnar basalt. The flints when broken open are found "to exhibit concentric bands of various tints of red surrounding a grey interior, and coated by an external white envelope." This reddening of the flints had

heretofore been regarded by Professor Jukes as due to the igneous action of the basalt. Now, however, he announces a fact which explains this explanation away. Above the gravel, but underlying the basalt, he has found a thick bed of clay, enclosing a thin layer of lignite, which in some places had the appearance of coal. Hence he concludes, that as the heat of the basalt did not indurate the clay and alter the lignite, it could not possibly have affected the flints.—Vide *Geological Magazine*, August.

The Geology of the Ancients.—In a work which deals with the geological attempts of the Greeks, from the earliest ages down to the epoch of Alexander, Dr. Julius Schvarcz arrives at the following conclusions:—(1) The Greeks were acquainted with all four classes of volcanic action, earthquakes, thermal springs, solfataras, volcanoes proper. (2) The Greeks also observed and investigated the phenomena of alluvial activity. (3) The changes taking place in the organic world did not form a part of the study of the Greeks, for they had arrived at no idea of a "genus" or "species," nor even of the distinctions of animal and vegetable kingdoms. The whole life of the universe appeared to them as the life of an organism, ever fluctuating, without any such pivots as the divisions and subdivisions of our modern zoological and botanical classifications. Their idea of the origin of animals was that genesis was not yet finished, but was going on in the days of Pericles, even in the formation of new stars. (4) They knew and understood the real organic origin of fossils; it was only in the time of Aristotle that such remains were attributed to "peculiar species of animals living underground." (5) The doctrine of the gradual degeneration of mankind, common to most Greek sages, may have originated from the misinterpretation of the huge fossil skeletons of Pachyderms, discovered in Greece, and held to be the remains of men of gigantic size. (6) Perhaps the highest idea which seems to have been actually arrived at by Aristarchus in the third century before Christ—if not at a far earlier *i.e.* Babylonian period —was the Heliocentric idea, that "those stars which do not err, and the sun, remain immovably at rest;" and that "in the circumference (orbit) of a circle the earth is moving around the sun, the latter being placed in the centre of the orbit."

British Fossil Crustaceæ.—Workers in the interesting but difficult department of Palæontology should consult the various important memoirs which are being contributed from month to month to the *Geological Magazine* by Mr. Henry Woodward. Each paper is accompanied by a lithographic page-plate in Mr. W. West's best style.

A new Freshwater Deposit near Stoke Newington has been discovered by Mr. Alfred Tylor, who in a letter to the *Geological Magazine* for August, gives an account of the locality, the beds, and the fossil treasures.

The last Meeting of the Geological Society.—The large number of valuable papers read at this meeting precludes our giving more than a short notice of two or three of especial interest. The first of these was on the *distribution of flint implements in Southern India*, and was presented by Mr. R. Bruce Foote, of the Indian Geological Survey. The chipped stone implements of Southern India are found in, or associated with, two formations—the coast-laterite, which is a marine formation, and a freshwater deposit, occurring inland at greater elevations above the sea. Most of them have been found

either *in situ* in the laterite of the eastern coast, or distributed over its surface; several have been collected off the surface of older rocks, in places where the laterite had been removed by denudation; others have been discovered on the surface at great elevations in other parts of the country, where no distinct traces could be seen of the formation from which they had weathered out, and which had a different origin (possibly freshwater) from that of the marine coast laterite; while a few have been obtained from unquestionably fluviatile deposits. None have been collected from formations known to be either younger or older than the coast-laterite. The author inferred that during the latter part of the laterite-period the land was raised to the extent of 500 or 600 feet; that this elevation was followed by a period of quiescence, during which the laterite was extensively denuded; that this epoch was succeeded by a period of depression, during which the recent coast-alluvium was formed; and that a subsequent elevation brought the land into its present position.——A paper by Mr. A. Leith Adams put the question, *Has the Asiatic Elephant been found in a fossil state?* An elephant's tooth in the possession of Dr. Fischer, of St. John, New Brunswick, which had been found in Japan at a distance of forty miles from the sea-shore, between Kanagawa and Jeddo, and at the base of a surface coal-bed, appeared to the author referable to the Asiatic elephant; and he accompanied his description of it by a drawing and plaster cast. In a note appended to the paper, Mr. Busk gave some further details of the characters exhibited by the cast, and agreed with Dr. Leith Adams in regarding it as probably referable to *Elephas indicus* rather than *E. armeniacus*, a fossil molar of which had been found in China; but he concluded that it was the *antepenultimate* upper left molar, and not the *penultimate*, as inferred by Dr. Leith Adams.——Mr. W. Boyd Dawkins described *a new species of fossil deer from Clacton.* This species (named *Cervus Brownii* by the author) is unlike any other species excepting *C. dama*, to which it is closely allied. The antlers, however, have the third tine present on the anterior portion, while in the fallow deer it is entirely absent. From the presence of *Rhinoceros Merkii* and *Elephas antiquus* in the Clacton deposit, and from the absence of Arctic species, the author regarded it as forming a term in the series of strata to which the Lower Brickearths of the Thames Valley belong, and as deposited before the immigration of Arctic animals into Great Britain.——Finally Mr. J. W. Salter read a note on *a true coal plant from Sinai.* The fossil described was received by Sir R. I. Murchison some years ago. The author regarded it as an infallible indication of the presence of the true northern coal-formation, with species like those from the Erekli coal. The proposed name of the species is *Lepidodendron mosaicum.*

Relation of the Norwich Crag to the Mammal Bed.—At the meeting of the British Association, Mr. J. E. Taylor read a paper in which he urged certain reasons for the separation of the true Norwich crag from the mammal bed. The conclusions generally expressed were that the whole of the mammaliferous bed above the chalk and beneath the crag as described by Mr. Fisher, was quite distinct from the true crag; a few shells interlocated having found their way when the land surface was lower, so as to form the shallow bottom of an estuary. That the *total* absence of freshwater and land shells in the

upper crag, and the predominance of those usually found at a greater sea depth, indicated that this bed was formed under more distinctly marked marine conditions than the lower or fluvio-marine crag. The paucity of shells in the former, and their immense abundance in the latter, was another proof of their separate and distinct conditions. Meantime, the increasing cold was proved by the abundance of northern shells in the upper beds, as compared with the lower. In short, the upper crag was one more intermediate link in the evidence of refrigeration, as proved by the coralline crag upwards; and the succeeding glacial series was only the result to which a study of the various crags necessarily led the investigator.

Fossils of the Mineral Veins in Carboniferous Limestone.—At the same meeting Mr. Charles Moore, F.G.S., read a paper upon the above subject, in which he said his attention had been called to it from the fact that the mineral veins in many instances contained organic remains, by a study of which it was not only possible to arrive at the age of the veins in their several districts, and also to some extent the physical conditions associated with them at the time they received their contents. After referring to his published views on the veins occurring in the carboniferous limestone in the Somersetshire and South Wales district, the author gave the results of his daily examinations of 134 different samples derived from the mines of Cumberland and Yorkshire. Of those 134 samples he had found organic remains more or less abundantly in not less than eighty—a fact sufficient to show that, as a general rule, they might be found in almost every vein if a careful examination be given to its contents. Amongst the organic remains, chief interest would attach to the presence of *Valvata* and other freshwater shells, often in great abundance and in districts wide asunder. Of Vertebrata he had obtained teeth and scales of *Petalodus*, *Ctenoptychius*, &c., &c.; Foraminifera were generally very rare; while Entomostraca of several species were the most constant organisms, Encrinites excepted.

Human Remains from Portugal.—In exhibiting some specimens to the British Association, Mr. W. Boyd Dawkins said that they were brought from caves which appeared to belong to the time called prehistoric. There were three caves—the Casa de Moura, Fapa da Fourada, and the Cora da Moura, and they all contained similar deposits. One of them ran horizontally. The one at the bottom contained a quantity of sand and gravel, containing some curious remains of animals—the wolf, dog, lynx, and fox. In the interior there was a human skull. Up above this was another bed of sand and gravel, containing, also, thousands of remains of human beings and animals. All the bones were more or less smashed, and a great many of them were scraped. They also found some of those stones commonly called neolithic. These were the remains of the feasts of the cannibals. There were also found some plates of schist rudely sculptured. There was also some Celtic pottery, ornamented with lines and dots similar to that found in England.

MECHANICAL SCIENCE.

Road Tramways.—A new system of tramways for common roads, intended to obviate some of the objections to those previously introduced, is proposed by Messrs. G. Remington & Sons.

Railway Tracklayer.—A paragraph quoted in *Engineering* from a Californian journal describes a machine introduced on the Pacific Railroad for laying the rails and sleepers during the construction of the line. The machine consists of a car 60 feet long with an engine for working the lifting machinery, which deposits regularly on the line the sleepers and rails in their proper position. The machine is pushed forwards by a locomotive, and the work is done so rapidly that 60 men are required to wait on it, but they do more work than twice as many could do on the old system. It is said to be able to lay five or six miles of track per day, or twelve times the usual rate by hand.

The Glatton.—The Admiralty have just commenced to built at Chatham Dockyard a turret vessel surpassing in defensive power any hitherto constructed. This vessel—the *Glatton*—is to be of 2,700 tons burden, 245 feet long, and 49 feet beam. Her exposed sides are to be covered with 12 inches thickness of iron, and her single turret with 14 inches, laid on teak backing 10 inches thick, with the usual inner skin plating. She is to be armed with two 25-ton guns, and driven by engines of 500 horse power (nominal). Her speed will not be great, as she is intended for coast defence. Her draught will be 19 feet, and she is to be built from the designs of the Chief Constructor of the Navy.

Propulsion of Ships.—Mr. C. W. Merrifield, F.R.S., has called the attention of the British Association to the slender basis on which theories of the motion of bodies in resisting media are founded, and particularly to the great deficiency of experimental knowledge on which to establish the laws of the propulsion of vessels. He proposes that experiments should be made, not on models, but on a large scale. He wishes to have ascertained, not only the exact motive power exerted in driving the vessel, but the velocity and direction of the currents of water at every po nt in the neighbourhood of the vessel in which it may appear useful to observe them. It is obvious that no private person can carry out such experiments except at a ruinous cost in chartering vessels, whilst a Government maintaining a fleet in time of peace may not unfrequently be able to detail both suitable ships and scientific officers, for experimental objects, instead of simply cruising for exercise. He therefore suggests to the Association to memorialise the Government, stating their opinion as to the value of such experiments and as to the proper mode of carrying them out. Mr. Merrifield has himself made several suggestions as to the latter point.

Resistance of Ships.—Professor Rankine has called attention to a neglected element in the resistance of ships, depending on the excess of the speed of the ship over the natural speed of the waves accompanying her, which natural speed depends on the depth to which she disturbs the water. Professor Rankine gives the results of three observations of the speed of advance of the obliquely diverging waves raised by ships. He has calculated the

vertical depth of disturbance corresponding to the ascertained velocity of these waves, and he finds it to correspond nearly with the mean depth of the vessels.

British Association Meeting at Norwich.—Amongst the papers read before the Mechanical Section, we may mention one on Centrifugal Pumps by Messrs. J. & H. Gwynne; one by Mr. L. E. Fletcher, C.E., on Boiler Explosions and Coroners' Inquests; one on the Utilisation of Convict Labour, particularly with reference to the application of the motive power to tread-wheels, on which hard labour sentences are generally worked out, to weaving, by Mr. Appleby; a paper on the Norfolk Broads, as a source of water storage and supply, and with reference to the improvement of the land in their neighbourhood by drainage; and a paper on the means in use and proposed to be used for the Irrigation of Lombardy, by Mr. P. le Neve Foster. Mr. Whitworth also returned to the subject of flat-fronted projectiles, which he first invented, and which (in spite of Major Palliser's successes) he still elieves to be in many cases superior to any other form in penetrative power, and to be alone capable of entering and passing through water.

Boiler Explosions.—Mr. L. E. Fletcher asserts that the experience of the Manchester Association for the prevention of these accidents proves that they arise from the simplest causes, and are perfectly within the grasp of common knowledge and common care to prevent. He gives some remarkable instances of the unscientific and absurd evidence sometimes given and accepted at coroners' inquests, and recommends a more adequate investigation by competent scientific engineers in all cases of fatal boiler explosions—the account of the enquiry, with the engineers' reports, being printed and deposited in the Patent Office. He believes that this course would do more to prevent accidents and be less objectionable than the Governmental inspection of boilers so often recommended by juries.

Dynamite.—M. Nobel read a paper at Norwich on Dynamite, the name given to an explosive material intended for mining purposes. It consists simply of 75 per cent. of nitro-glycerine mixed with and absorbed by 25 per cent. of highly porous silica. The mixture renders the nitro-glycerine solid or pasty, and does not in any other way affect its properties. But if M. Nobel's opinion be correct, that the danger of nitro-glycerine is due almost exclusively to its liquid form, this improvement in the mode of using it is most important. M. Nobel exhibited a block of wrought iron, 11 inches diameter and 12 inches high, rent in two by a charge of only 6 ounces of dynamite, simply placed in a bore-hole at the centre, without any plug or tamping. To prove its safety, he mentioned that a box containing 8 lbs. (equal to 80 lbs of gunpowder) placed over a fire, slowly burned away without explosion, and that a box containing the same quantity had been dropped 60 feet on to a rock without igniting by concussion.

Path of Projectiles.—Mr. Merrifield has investigated the form of the path of a projectile, on the assumption that the resistance, as shown by Professor Bashforth, varies as the cube of the velocity. He finds the path to bear a rough resemblance to one branch of an hyperbola, with one of its asymptotes vertical.—See *Engineer* for August 21.

Moncrieff Gun Carriage.—This remarkable and novel arrangement of gun carriage has just been tried at Shoeburyness, in presence of the Ordnance

Select Committee, with very satisfactory results. The principle of the invention is that the whole momentum of the recoil of the gun should be absorbed in lifting a heavy balance weight, the gun itself at the same time descending in a cycloidal curve under protection of the parapet. Having descended, the gun is held by a self-acting pawl until it is loaded, by gunners perfectly protected from fire, and the work stored up in the balance weight during the recoil is then sufficient to raise it to the firing position, above the parapet, its ascent being regulated by a friction break. The exposure of the gunners when the guns are placed *en barbette* on the ordinary system, and the weakening of the parapets when pierced by embrasures, are thus equally avoided, and the labour of training the gun is at the same time reduced to a minimum. Captain Moncrieff has further devised optical means by which the aiming of the piece may be effected without the exposure of a man to hostile fire.

Railways for Steep Inclines.—Amongst the modes of obtaining increased grip or adhesion to enable steam power to be employed on steep inclines, it has been suggested that the wheels of the locomotive or traction engine should be allowed to run on a road formed in the ordinary manner, whilst the wheels of the waggons only run on the rails. The tractive force necessary to draw a given load on rails is thirteen times less than on common roads, and conversely the adhesion or grip of a given engine on a common road must be about thirteen times greater than on rails. M. Larmangat has submitted a plan based on this principle to the French Emperor. It is not impossible that, in cases where the expense of a more perfect system would preclude its adoption, this simple expedient of a composite road may be useful.

Liquid Fuel.—In reference to a note on this subject Mr. C. J. Richardson addresses the following explanation :—You favour me in your late number in noticing Captain Selwyn's lecture on liquid fuel, to state that I have formed a theory " that the water or steam introduced with the liquid fuel, and which seems necessary with its successful use, is decomposed, and the heat of the combustion of the hydrogen added to that of the liquid hydrocarbon ;" and you add, " it is difficult to conceive that an additional heating effect can be gained in this way." Will you please permit me to explain? I do not hold any such notion as you describe. All liquid hydrocarbons when burnt in a furnace require such a large amount of oxygen that it is not possible by the usual way of admitting air to supply it, and hence there is an enormous amount of carbon in the form of soot and smoke. Now, by introducing a little steam into the furnace and decomposing it—and the hot fiery liquid fuel does this readily—the oxygen water-vapour immediately attaches itself to the escaping carbon, or soot, or smoke of the liquid fuel, great heat evolves, the fire clears, and there is no smoke. The hydrogen of the water escapes as it likes, it is sure to act well, but it is the oxygen that does the work. Thus, although the combustion of the water gases may give no heat themselves, they serve to use up or make the liquid fuel give all the heat it is capable of, 1 lb. of it vaporising 18 to 19 lbs. of water according to my process, as returned by the Government Engineers. You often see a locomotive sending forth a dense column of black smoke, and by the side of it an equally dense column of white steam. If the latter

could be passed through the furnace no black smoke could be formed at all, and the fuel would do nearly twice the work. With liquid fuel the operation is easy, and the exhaust steam would suffice—but that, as I say, must be twenty years hence.

MEDICAL.

The Physiological Action of Extract of Meat.—If we are to believe the conclusions at which Herr Kemmerich has arrived, the extract of meat, which is now so generally employed by invalids, is an article of diet which has a very grave physiological action on the system, and which should not be taken in very large quantities. In fact, Herr Kemmerich would have us believe that *Extractum Carnis* must be looked on rather as a drug to be prescribed by the physician than as a form of food pure and simple. His first conclusion is, that in the smaller doses this preparation increases the number and strength of the heart's contractions, but that in larger doses *it acts as a poison*, and kills with all the appearances of *cardiac paralysis.* In cases where the dose is very large and concentrated, death is extremely rapid, and the arrest of the heart's action is accompanied with convulsions. The second conclusion arrived at is, that the active principle in meat soup, which, in smaller doses, acts as an excitant, and in larger doses as a poisonous agent, is to be found chiefly in *the potash salts.* Kemmerich took the exact quantity of flesh extract necessary to produce poisonous symptoms, and reduced it to a mere *ash*; the solution of this ash produced almost exactly the same poisonous symptoms as the larger doses of flesh extract produced. It is well-known, however, from the most recent analysis, that the salts of flesh are made up to the extent of more than ninety per cent. of potash salts; and it need not be mentioned that potash salts are distinctly depressive to the heart. The third conclusion, however, is, that the smaller and medium doses of potash salts are not able to produce the poisonous effects. On the contrary, from direct experiments, by injection under the skin, and by gastric administration of chlorate and sulphate of potash, both in dogs and man, Kemmerich determines that these lesser doses are excitant of the heart's action. Kemmerich points out that the opposite results obtained by Traube may be explained by the fact, that (owing to his injecting into the external jugular vein) he threw into the coronary circulation a comparatively large and undiluted quantity of potash, which could scarcely be other than paralysing to the muscular tissues.—Vide *The Practitioner*, August.

The Electrolysis of Tumours.—In a recent memoir M. Scoutetten shows that it is absurd to speak of the action of the galvanic current, in the removal of tumours, as an instance of electrolysis. "Take, for instance," says M. Scoutetten, "a hydrocele tumour containing a hundred grammes of liquid. By passing through this a current from a medium-sized pair of Bunsen's elements, we may completely remove the tumour in the course of twenty minutes, or half an hour at the utmost. Could this have been achieved by electrolysis? No: firstly, because such a battery as that referred to could not decompose a greater quantity of water than 4½ grammes in an hour; and

secondly, because, if it did decompose the 100 grammes in that time, it would develope such a volume of gas as to convert the unhappy patient into a balloon." M. Scoutetten concludes that the process is a physical one of a different kind, the effect of which is the rapid absorption of the liquid of the tumour; and hence he terms it *electric resorption*.—Vide *Comptes Rendus*, August 3.

The Physiological Action of Belladonna.—M. Meuriot recently contributed a paper (since published separately) to the *Bulletin générale de Thérapeutique* (July) on this subject. His conclusions are numerous, and some of them are of interest. In a poisonous dose he says that this drug acts as a *paralysant* on the respiratory organs, and this he attributes to its primary influence over the pneumogastric nerve. The effect of atropine is first to destroy the general sensibility, and afterwards the excitability of the motor nerves. He denies that belladonna has any special action on the brain, and attributes all its cerebral effects to the disturbance which it produces in the whole circulation. He finds that it increases the temperature from about half a degree to a degree, and that this increase corresponds to the increased heart action. When the action of the heart is lowered the temperature is also diminished.

Composition of Milk.—So few analyses of milk have been recently published, that we extract from an American journal the results of the analyses made by Professors Müller and Eisenstück, of the Royal Agricultural Academy of Sweden. The analysis was made of milk collected at different times of the day and year, and gave very uniform results. The highest percentage of water was 88·35; the lowest 85·02. The following is the tabular statement:—

Fat (butter)	4·05
Albumenoids (caseine, &c.)	3·32
Sugar of Milk	4·71
Ash	0·73
Water	87·19
	100·00

—Vide *New York Medical Journal*, August.

The Preparation and Determination of Cantharidin.—M. A. Fumouze gives the following method for this purpose:—Powdered cantharides are macerated with chloroform for twenty-four hours, and this treatment is repeated twice with fresh quantities of solvent, the residue having been well squeezed each time. The collected solutions are then distilled, and the dark green residue treated with carbonic disulphide, which dissolves fatty, resinous, and other matters, and precipitates the cantharidin. The precipitate is thrown on a filter, washed with carbonic disulphide, and recrystallised from chloroform. The same process, omitting the final recrystallisation, may be used for the quantitative estimation of cantharidin in cantharides. The average quantity found was from four to five grammes in one kilogramme.—Vide *Journ. Pharm.*, vi. 191.

Progress of Ovariotomy.—This formidable operation, which was so gravely decried when first proposed, has in M. Kœberle's hands conferred the greatest blessings on humanity. The following tables, showing the results of M. Kœberle's operations from 1862 to 1868, are adequate proof of the

success of this operation in the hands of the surgeon who makes himself master of it:—

The 1st year,	in	6 cases		1 death		
„ 2nd	„	4	„	2	„	
„ 3rd	„	8	„	2	„	
„ 4th	„	9	„	4	„	
„ 5th	„	19	„	9	„	
„ 6th	„	23	„	6	„	

Snake-bites as a Preventive of Hydrophobia.—In an article which appeared in *Les Mondes* (July), a very extraordinary statement was made to the following effect:—*Hydrophobia is absent from Spain, the reason being that the people who are bitten by mad dogs have been previously bitten by the various snakes of the country. This belief is so prevalent among the inhabitants, that they regularly submit their children to serpents, that they may be bitten, and in this way avoid hydrophobia in after years.* When we first read this statement we put it down as an impudent falsehood. We are, therefore, glad to perceive that it has received denial from one thoroughly qualified to give an opinion on the subject. M. Ramon de la Sagra, a Spaniard himself and a physiologist, whose name is well known abroad, has sent in a note to the French Academy, in which he says that the statement in *Les Mondes* is utterly false. Hydrophobia is common enough in Spain, and exists in both the canine species of that country, the dog and the wolf; and "ophidian inoculation" is never dreamt of. The usual means of treating the wound is by deep cauterisation. If this does not suffice, the physician waits till peculiar vesicles appear on the tongue; these are then pierced with a red-hot needle, and the mouth is frequently and daily gargled. This treatment, he says, is attended with excellent results.—Vide *Comptes Rendus*, August 31.

On the Molecular Modifications that Tension produces on Muscle is the title of a paper presented to the French Academy (July 13) by M. Chmoulewitch. The author questions some of the propositions of Weber, and draws some interesting conclusions in relation to the development of heat and electricity.

Flukes from the Indian Elephant.—At the British Association, Dr. Cobbold gave a description of a new species of fluke removed from an elephant which had died at Rangoon. Professor Huxley had also received specimens from Burmah, accompanied with statements to the effect that the distoma in question had given rise to an epidemic in that country. In point of fact, the "rot" disease was affecting these huge pachydermatous animals. The entozoon previously noticed by Dr. Jackson, of America, had never been properly described. Specimens (probably of this species) were preserved in the museum of the "Boston Society for Medical Improvement and Observation." The parasite was not, as had been supposed, a species of distoma. It was closely allied to, but quite distinct from, the common fluke. Several of the examples transmitted to Professor Huxley might now be seen in the Hunterian Museum at the Royal College of Surgeons. It was explained that the prevalence or absence of any particular species of trematodes during any season was due to varying atmospheric influences. Thus an unusual amount of wet and heat was eminently favourable to the development of the larval or cercarian forms which immediately preceded the

adult state. The number of individuals agamogenetically produced bore a strict relation to the conditions under which their immediate progenitors were placed.

The Physiology of Pain.—Professor Rolleston, who read a paper on this subject at the British Association, said it was a common mistake to suppose that pain was an exaltation and excitement of function, for it might also be occasioned by a lowering of functional activity, brought about mainly by starvation or shock. The pain from shock was produced by a sudden impact without the intervention of blood-vessels, though not without the intervention of the tubes containing nerve matter. The author adverted to a number of facts bearing on these theories, humorously concluding with the observation that they would side with either of two theories, both of which (in defiance of metaphysicians) he was inclined to hold.

METALLURGY, MINERALOGY, AND MINING.

The Gold Mines of Transylvania.—A paper on these mines was some time since read, says the *English Mechanic*, by Herr Tschermak before the Imperial Geological Institute. It appears that the precious metal is found disseminated in almost imperceptible particles in the trachytic rocks in the environs of Falathna and D'Abrud Banya, where it is still worked by the most primitive methods. There are 300 families or partnerships, consisting each of three individuals, or thereabouts. A thousand quintals of the rock yield about 8,500 grains of pale yellow gold, which contain a little silver. The rolled *débris* of the crystalline rocks found in the valley of l'Aranyos is carefully washed, and yields about half an ounce of gold to 31,000 quintals of stuff. This gold is of a deeper colour and contains less silver. They also find gold in a peculiar freestone (*Carpathiques bocardes*), which is of a pale colour, like that found in the trachytes. The gold mines of Transylvania have been worked from the earliest historic times, yet they still furnish above 2,000 lbs. avoirdupois annually.

The Chemical nature of Cast-iron.—At the meeting of the British Association the report on this point by Dr. Matthiessen and Dr. Russell was read by the latter and led to some discussion. It seems, that though no less than seventy experiments were made in the production of pure metallic iron from its various compounds, the reporters had not succeeded in obtaining any iron perfectly free from sulphur. Dr. Matthiessen hoped, however, by continuing his researches, yet to obtain a perfectly pure sample of metallic iron. In the course of the discussion which followed, Mr. Sutton suggested that probably the presence of sulphur in iron was only another instance of the persistence of that element in the atmosphere, as shown by the experiments of Mr. W. F. Barrett, who first devised the method of detecting the presence of sulphur upon the surfaces of bodies exposed to the air by projecting upon them a flame of hydrogen, a magnificent blue flame resulting therefrom.

The Phosphorescence of Minerals.—M. Kindt has recently made known the nature of the phosphorescence developed by heat in three minerals, chloro-

phane, Estramadura phosphorite, and the green fluor spar. He has analysed the light emitted: the first is a simple green; the second is a yellow tinted light, composed of green, yellow, and red; and the third gives two black rays, the one in the green, and the other near the orange.

The Composition of Pyrites Residue.—Dr. Phipson has communicated to the *Chemical News* (July 17) the result of his analysis of the residue of pyrites obtained in the Drumburgh Chemical Works, Cumberland, where Norwegian pyrites is principally burnt:—

Oxide of zinc	5·50
„ copper	2·86
„ manganese	1·60
„ nickel and cobalt	0·12
„ cadmium	0·01
„ lead	1·67
„ antimony	0·04
Protoxide of iron	1·17
Alumina	3·25
Arsenic	none
Sulphur	2·60
Thallium and indium	trace
Rock	15·00
Peroxide of iron (by difference) direct 67·00	65·99
Lime	0·11
Magnesia	0·08
	100·00

The Iron Works of the 'Weald.'—At the meeting of the British Association, W. Boyd Dawkins, M.A., F.R.S., read a paper 'On the Iron Works of the Weald,' in which he expressed the opinion that the works were carried on by the Romans. Few persons, he thought, could pass through the sparsely populated country between Tunbridge and Hastings without observing that they were in the midst of what not very long ago was the principal iron district of England. He believed that there was evidence worthy of notice that mining was carried on in the Weald some nineteen hundred years ago. An opinion was expressed, in the course of the discussion, that the works were of even still greater antiquity, and could be traced back to the early British times.

The Volatile Matter of Coal.—In a paper in the *American Journal of Mining*, Professor G. Hinrichs, in reporting his investigation made to determine the volatile matter of various specimens of coals, thus sums up his remarks. The total volatile matter of coal is determined with accuracy (1 mgr. on 1 gr. coal), by taking 1 to 2 grammes of undried, pulverised coal, heating it for three and a half minutes over a Bunsen burner (bright red heat), and then immediately, without cooling, for the same length of time, over a blast gas-lamp (white heat).

The Preparation of Thallium.—At the white vitriol works of the Lower Hartz there is obtained by lixiviating the roasted ore in water a liquor which is rich in thallium. This rare metal may, according to Bunsen, be extracted from this liquor by precipitating, by means of metallic zinc im-

mersed in the liquor, the metals copper, cadmium, and thallium, jointly. The metallic spongy mixture thus obtained is rapidly washed—first with water, by being placed in a bag made of woollen fabric; next, some sulphuric acid is added to the wash-water, whereby the metals thallium and cadmium get dissolved with evolution of hydrogen, while copper is left untouched; from the acid solution so obtained thallium is precipitated, by means of iodide of potassium, as a pure yellow iodide, which is further purified by washing and by decantation; from the remaining liquor cadmium is precipitated in the metallic state by zinc. One cubic metre of the above liquid yields in a few days 6·4 kilos. of spongy metallic precipitate, containing 4·2 kilos. cadmium, 1·6 kilo. copper, and 0·6 kilo. thallium, 7·4 kilos. of metallic zinc becoming dissolved. The solution of cadmium and thallium in sulphuric acid yields, on addition of 0·5 kilo. iodide of potassium, 0·97 kilos. of iodide of thallium. Thallium may be precipitated from the sulphuric acid solution by means of chlorides, but in so doing a not inconsiderable quantity of the metal is retained by the cadmium. The thallium may be directly obtained from the first liquor at once by precipitation with iodide of potassium, provided previously a sufficient quantity of hyposulphite of soda be added to keep the copper in solution; the application, however, of this latter method interferes with the object for which the liquor is prepared, viz., the making of sulphate of zinc.—*Polyt. Centralbl.*, 1868, No. 10.

Diamonds in Cape Colony.—At the British Association meeting, Professor Tennant made a communication on the recent discovery of diamonds in Cape Colony. This gem, he stated, had been found somewhat abundantly recently in the above district; and he exhibited the casts of some weighing 9 carats, worth 500*l.* Some agate, chalcedony, and other precious stones found in the same deposit had been sent him, but he would have preferred some of the sand and mud in which they were deposited. One diamond found very recently weighed as much as 15½ carats. He was of opinion that before long we should have a large collection of diamonds from the above country, adding that, although we had heard a great deal of diamonds being found in Australia, those stones were not worth now so many pence as pounds had been asked for them.

METEOROLOGY.

The Nature and Phenomena of Hail.—M. the Abbé Lecompte has been good enough to send us a copy of his very valuable memoir on hail, which has just been published in the Proceedings of the Royal Society of Belgium. All who care for this department of meteorology should possess the memoir. We shall, however, give a few of M. Lecompte's conclusions, which are generally expressed in a vast number of tabular schemes and curve-diagrams. From a series of observations extending over three years he concludes that the greatest quantity of hail falls in March and April, and also that more falls between three and four in the afternoon than during any other two hours in the twenty-four. As to the form of the hailstone he says he has observed that the stones are most usually small globular

opaque masses of ice, which have generally a fibrous structure. They are never completely transparent save when they have been moistened by a shower of rain. When large, they seem to be formed of concentric layers, which enclose a central snowy-looking opaque nucleus. He asks the question whether the huge hailstones sometimes seen are formed in the usual manner, or are due to the regelation of a number of hailstones. His own experiments have shown him that even hailstones as large as a hen's egg have only one nucleus like the ordinary hailstone. Hence he concludes that these large stones are formed in a manner similar to the smaller ones. M. Lecompte admits the difficulty of drawing definitive conclusions as to the causes productive of hail, but he thinks we may admit that the immediate cause is frequently the conflict of two opposite winds, one of them bearing masses of warm vapour, the other being, on the contrary, cold and dry, thus precipitating the vapour into drops subsequently frozen. M. Lecompte's interesting memoir is published by M. Hayez of Brussels.

Change of Climate in India.—In an article which lately appeared in the *Madras Times* the writer urged upon amateurs and the Government to make an effort to establish a systematic scheme of meteorological observations. The reason for this, they say, is that even common experience shows how the climate of India has changed during the last twenty years. It would be very interesting, says the writer, to consider the atmospheric changes of the last ten years in the chief districts of the Madras Presidency. That their climates have changed to an extraordinary degree he has no doubt whatever, taking the present year of 1868 and the recollections of residents into consideration. Secundrabad, Bangalore, and Vizagapatam are remarkable instances of the changes in question. At the first-named station, the "cold weather" in former years was proverbial. "The delicious cold weather of Secundrabad" is still spoken of by individuals who would find it by no means chilly at the present day; and at Bangalore the fire-places of the old houses prove how much colder was its climate in former years than at present. Old sepoys have informed him also that in Bangalore, some twenty years ago their fingers were so benumbed with cold on early morning parades, that they found some difficulty in holding their muskets, whereas they now cannot complain of the cold being in any degree unpleasant. Vizagapatam, again, some years ago, was usually regarded by officers as a favourite military station on account of its pleasant, bracing weather; but now, the writer is assured, it is as hot as Cuddapah, a station, by the way, which, in the see-saw of atmospheric phenomena, is apparently becoming cooler as its rivals become hotter. Also, in many stations, there is a great difference observable in the annual rainfall. In some it has greatly increased; in others it has greatly lessened on the average of former years. And the same may be said of the heat, which is equally capricious with the rain and the cold. 1868 will, he trusts, long be remarkable as an unusually hot year in some stations, and as an unusually wet one at others—Madras, for example. For very many years such heat has not been experienced in Bangalore and Hyderabad as during the past hot seasons. The natives have a saying that "plenty of rain and plenty of cold follow plenty of heat;" and this has been the writer's experience. The unusual rainfall in Orissa and Cuttack this season is as extraordinary as the unusual heat in the

Punjaub and Scinde. Parts of Orissa have been literally under water, and the unfortunate people of that most unfortunate country have been compelled to move over their fields and plantations in boats and rafts. Again, the frightful storms and typhoons which have of late years succeeded each other with extraordinary rapidity in various parts of India, show apparently the unusual character of our present Indian seasons. He cannot accept these phenomena as natural or indigenous to the climate. Until recently, except at very long intervals, this country was not vexed with storms rivalling in strength and destructiveness the tornadoes of the West Indies, but of late these terrible visitors have been very common. The Government might wisely pay more attention to atmospherical phenomena in this country than it does at present; and such attention would reap its reward, if not in obtaining the power of averting calamities, of at least alleviating them.

The past Hot Summer.—While we may leave meteorologists to decide as to the cause of the tremendously high temperature of the past summer, it is very interesting to turn over a file of the *Times*, and read the meteorological correspondence of the days of greatest heat (the Wimbledon encampment time, about July 21). Mr. J. H. Stewart, "optician to the National Rifle Association," wrote a letter to the *Times* to say that on July 21 the heat in the shade at Wimbledon was 101° Fahr. This was a very startling statement, and it naturally suggested questions as to the character of the thermometer, the position of the sun's rays, &c. It would seem, from the observations (communicated to the *Times*) of Mr. G. J. Symons and Mr. R. H. Allnatt, two of our most eminent practical meteorologists, that there were various sources of error in Mr. Stewart's mode of taking the temperature. Alluding to Mr. Stewart's assertion that the heat at Wimbledon was 101°, Mr. Symons says it was only 92° at Putney, 91° at Epping, and 93·3° at Camden Town. The discrepancy between these returns and Mr. Stewart's can, he thinks, be only explained by supposing that "the thermometer was not in true meteorological shade, which the inside of a tent certainly does not produce." Mr. Stewart's sun temperatures appear to Mr. Symons to have been equally inaccurate, for he says, "Mr. Stewart's sun temperatures are as much too low as his shade ones are too high. He reports 128° for the 21st. Solar radiation observations are not at present in a satisfactory state, but mine have been recording between 140° and 150° for a fortnight. Still I do not attach much weight to that, because the temperature in sun depends almost wholly on the form of mounting. I remember seeing on a lawn in Wiltshire a box with a glass lid and lined with black cloth, wherein was a small black metal can with a tube led through the side of the box; the water in the can was boiling, and steam issuing from the pipe; obviously a thermometer therein would have read considerably over 200°. At Greenwich upwards of 160° has been recorded by a black bulb thermometer lying on the grass. I therefore object to 128° at Wimbledon, but in a far less degree than I do to the preposterous shade temperatures of 100° and 101°."—Vide *Times*, July 23.

Synoptic Weather Charts.—At the meeting of the British Association, Mr. Meldrum read a paper on this subject, in which he stated that the object of the charts was to show the state of the winds, weather, &c., at the same

moment of *absolute* time on each day for one or more years. After describing his own (now abandoned) efforts in this direction, he stated that the amount of material collected by the Meteorological Committee of the Royal Society gave one hopes of the early production of some of these charts. Mr. Meldrum exhibited engraved specimens of the charts, and pointed out the leading features of each, showing the existence, on the days in question, of several revolving and other storms, and calling attention to the fact that there was apparently a strong tendency in the wind to blow tangentially to the isobaric curves, but that it was only a tendency, the direction of the wind being generally more or less inclined to the isobars. In conclusion, Mr. Meldrum strongly argued the importance of mapping the weather daily as it existed at a particular hour over extensive areas, that being, in his opinion, the most efficient way of solving many questions of great scientific and practical importance. Who could doubt that, if we had charts showing the daily state of the weather, barometer, &c., at a certain moment, over the North Atlantic, the continent, and the British Islands, for even the last twelve months, we should know much more than we do regarding questions of the utmost importance to navigation? He believed that to the practical sailor synoptic charts would be at least as valuable as average charts; that a chart showing the winds and weather actually observed over a certain extent of ocean on one day of normal weather would be fully as trustworthy a guide as a chart showing the average on prevailing winds obtained from one to three months' observation. But however that might be, and without underrating the importance of averages and constants, there could, he thought, be little doubt that meteorology would be more promoted by the synoptic or synchronous method than by that of averages.

The Report of the Rainfall Committee.—This Report was "brought up" at the meeting of the British Association, by Mr. G. J. Symons. It is full of important matter, and deserves a longer notice than our space admits of. It offers some sound advice on the management of rain gauges.

MICROSCOPY.

A Camera Lucida for Vertical Use.—One so often requires to take a drawing of specimens freshly placed in liquid on the microscope stage, that it becomes of some importance to be able to employ the camera lucida, or tint-glass reflector, for this purpose. As the instrument has been hitherto arranged, this is impossible, for as the body cannot be inclined (since the specimen must be horizontal), the tint-glass reflector becomes practically useless. An ingenious appliance has just been manufactured by Mr. Charles Collins, optician, by which all the difficulty referred to is obviated. It consists simply in a right-angled tube containing in its angle a right-angled prism. The eye-piece of the microscope having been removed, this is fitted to the body, and in its other extremity is placed the eye-piece. The eye-piece is thus horizontal while the body and objective are vertical. The tint-glass is placed, as usual, in the eye-piece, and the instrument is

ready for the artist. By means of this simple contrivance drawings of specimens in liquid (Infusoria, &c.) may be readily taken, and we believe the cost of the apparatus is not great. This accessory was devised by Dr. Purefoy Colles, of Calcutta, late editor of the *Indian Medical Gazette*, and was prepared at Dr. Lawson's suggestion by Mr. Collins.

A Reversible Compressorium of an ingenious kind has been invented by Mr. S. Piper. It is something like Beck's reversible compressor attached to a horizontal rod which slides and rotates through a universal joint. It appears from the published drawings to be a most useful and convenient apparatus. It is made by Mr. Swift, 15, Kingsland Road, N.

A Condenser with a blue-tinted Field Lens is also made by the above manufacturer, on a plan suggested by Mr. W. H. Hall. Its advantages are thus summed up by its inventor in a paper before the Royal Microscopical Society. (1) It can be used with advantage with from 2-inch to ⅛-inch objectives. (2) It gives fine daylight softness. (3) It is an effective spot-lens and dark-ground illuminator, with polarized light. (4) The change from one form of illumination to another is made with great ease.

Nobert's Test Plate.—Those who are desirous of knowing what fractional part of an inch is made visible by the highest powers of our modern microscopes should read an interesting paper reprinted in the *Quarterly Journal of Microscopical Science*, July, from the *American Naturalist*. It is written by Mr. Charles Stodder.

PHOTOGRAPHY.

The British Association at Norwich.—Photography played a very minor part in the proceedings of the British Association for the Advancement of Science this year. The Report of the Kew Observatory Committee showed numerous and important applications of the art, and of their satisfactory nature. In section A. Mr. Bing described a new actinometer. It consisted of a rectangular tube of non-actinic glass, with an arrangement for bringing into contact with one side of the interior a strip of paper previously rendered sensitive to the action of light. The tube being placed in diffused light, with its open aperture exposed to the sky, the light darkens the paper in the ratio of its quantity, which necessarily diminishes as it proceeds farther into the tube, inside which, by the sensitive paper, is fixed a scale with divisions, marked by a portion of a faint standard tint. In the same section Professor Morren introduced a paper entitled *Sur une Action particulière de la Lumière sur les Sels d'Argent.* It contained nothing new.

New Carbon Printing Process.—Mr. William Blair, of Perth, has announced a new carbon process, the results of which—although it is not yet perfected—give great promise. The great advantage is, that the troublesome process of transferring used in other carbon processes is done away with. The process, briefly hinted, consists in substituting a white tissue for the ordinary black one, and mounting it upon a black instead of a white surface.

New Kind of Photographs.—A species of toy photograph has recently received some notice. It is obtained by coating paper or glass with a layer

of some phosphorescent substance, and then sensitising and exposing it to light in the usual way. A photograph thus taken is invisible in daylight, but in the dark becomes perceptible; shining with a greenish or purplish phosphorescent light, which produces a very odd and mysterious effect.

A New Doublet Lens.—Mr. Ross, the optician, has introduced a new instantaneous doublet lens at the suggestion of Mr. Stuart. Its equivalent focus is nearly 6½ inches, and the diameter of the lenses, which are equal, is about one inch; the distance between them is the same. It is fitted with a rotating plate containing four diaphragms, the largest of which is rather more than half, and the smallest about a quarter, of an inch in diameter. With the largest stop a circle four inches in diameter is covered sharply to the edge. It is spoken highly of by many of our best operators, and is becoming very popular for all kinds of work, views, portraits, &c.

A New Mode of Drying Plates.—Mr. Carey Lea has published in the *Philadelphia Photographer* a new mode of drying plates for dry photography. Sulphuric acid is placed in a dish large enough to hold three times the quantity put into it. This being placed in a box, the dry plates are ranged round it in a frame. The dish used should be a glass or porcelain one, about three inches deep. The acid will augment in bulk by absorbing water; when it attains about double its original bulk it should be replaced by fresh.

A Curious New Photographic Toy, called the Kinescope, has made its appearance. It combines the principle of the stereoscope with that of the Zoetrope, and consists of microscopic photographs in a piece of apparatus in general appearance resembling a Stanhope lens. It forms an elliptical medallion with two photo-microscopic cylinders in the centre, perpendicular to the thickness of the medallion. The object appears in two phases of motion, and the effect of moving is suggested by a rapid change produced by a guide about the cylinders, which are surrounded by a caoutchouc membrane, on which is a vertical rod terminating in a button outside the medallion. Putting the eye to the central aperture, you see only one of the images, and then, by pressing the button, the pictures are changed so rapidly, that the second image takes the place of the first before the impression made by the former has disappeared.

A New Developer.—Mr. Carey Lea, in the *British Journal of Photography*, states that he has discovered a new substance capable of developing the latent image. This is *hæmatoylin*, a substance which, after undergoing certain changes, becomes—although in itself almost white—the colouring matter of logwood. A solution of this, with a little acetic acid to keep its action under control, forms a very good developer—in some respects resembling the old pyrogallic developer.

A Substitute for Ground Glass.—Mr. Walter Woodbury has suggested the use of gelatine, rendered partially opaque by mixture with some white pigment such as oxide of zinc, to take the place of ground glass in backing up transparencies. The effect obtained is certainly superior to that given by the ground glass.

The Great Solar Eclipse.—Photographers went out from England, India, France, and Prussia, to photograph the solar eclipse of 1868, the greatest which has taken place for four thousand years. News have been received

leading us to suppose that the eclipse has been very successfully observed, and some very important photographs secured. It is understood that several plates were exposed with success by Major Tennant's party, and that a large measure of success has rewarded the North German Expedition at Aden, who secured three negatives of great value.

A New Camera.—Mr. Edward B. Tennessy gives, in the *Illustrated Photographer*, the following description of a new camera of a very portable and complete kind:—The covers, B B, of the double circular dark frame, A, are hinged at H H, the end of each hinge being allowed to project, so that on pushing the frame into the camera, a notch, N, left in the thickness of the camera, catches those projections and causes the covers to open. Before withdrawing the frame, it is turned so that the projection of the hinge fits into the groove, S, fig. 3; then, on pulling back the frame, the slide rises and

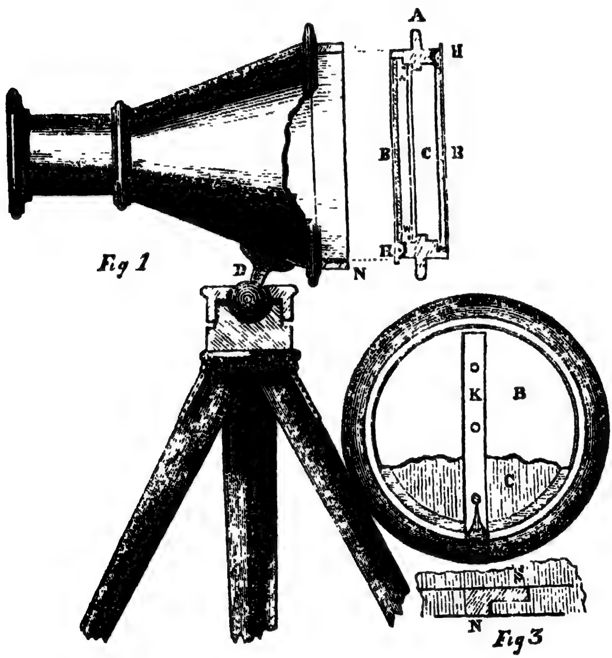

Fig 1

Fig 3

shuts. It is then turned back and withdrawn. The cover is retained sufficiently tight by the stiffness of the hinge, which could, if necessary, be assisted with a spring somewhat like that employed in the covers of watches; but if this arrangement of opening and shutting be considered inconvenient, it is easy enough to contrive a small pin and handle for the purpose. The covers or flaps, B B, are made of india-rubber, leather, thin brass, felt, or any such elastic material. They are fixed with studs to the brass arm, K, and when opened inside the camera, accommodate themselves to its conical body. The walking-stick tripod requires no further notice than to remark that the ball is permanently retained in the handle, the

part, D, of the camera screws when required into it. A section of the top of this tripod is shown, with the manner of cramping the ball. C represents a sensitised glass, which can be retained in place by a piece of flat spring wire partly surrounding it.

PHYSICS.

An Experiment in Diamagnetism.—Mr. W. E. Kernan has given an account of a new experiment which suggested itself to him some time since, and whose object is to show the diamagnetic phenomenon to a large number of people so as to be manifest to all at once. For this purpose a disc of copper is made to revolve between the poles of the magnet by a pulley and band from a steady source of motion—for instance, an electro-motive engine. The diamagnetic effect may be made manifest in three ways:—1st. The band is let to run somewhat loosely. As long as the current is not turned into the magnet coils, the disc moves with great velocity. The turning-in of the current instantly stops the disc, forcing the band to slip. Thus motion and stoppage of the disc can be exhibited alternating, until the effect is fully appreciated. 2nd. The band is drawn tight. The turning-in of the current does not now stop the disc, but the great diminution of velocity in the prime mover shows the effort of the magnet to stop the disc. Here, too, alternation may be used as before. 3rd. The axis of the disc carries a small wheel with many teeth; a card held against the teeth of the revolving wheel gives a fine clear high note (Savart's wheel). As long as the magnet is not in action the prime mover keeps up a fixed velocity, and consequently the wheel gives the same note. On turning-in the current, if the band slips the sound stops; if it does not slip the note is changed, from the decreased velocity of the prime mover. The alternations of sound and silence (or change of note) are very striking.

Cause of the igniting Power of Spongy Platinum.—This peculiar property of spongy platinum is supposed to be due solely to the influence of the metal on the occluded hydrogen. Professor Graham, however, offers the following representation of the phenomenon, with an apology for the "peculiarly speculative character of the explanation." The gaseous molecule of hydrogen being assumed to be an association of two atoms, a hydride of hydrogen, it would follow that it is the attraction of platinum for the negative or "chlorylous" atom of the hydrogen molecule which attaches the latter to the metal. The tendency, imperfectly satisfied, is to the formation of a hydride of platinum. The hydrogen molecule is accordingly polarised, *orienté*, with its positive or "basylous" side turned outwards, and having its affinity for oxygen greatly enlivened. It is true that the two atoms of a molecule of hydrogen are considered to be inseparable, but this may not be inconsistent with the replacement of such hydrogen atoms as are withdrawn, on combining with oxygen, by other hydrogen atoms from the adjoining molecules. It is only necessary to suppose that a pair of contiguous hydrogen molecules act together in a single molecule of the external

oxygen. They would form water, and still leave a pair of atoms, or a single molecule of hydrogen attached to the platinum.—Vide *Proceedings of the Royal Society*, No. 103, vol. xvi.

Value of the Aneroid Barometer.—Mr. Balfour Stewart lately addressed a paper to the Royal Society, in which he gave an account of certain experiments on aneroid barometers made at the Kew Observatory. These experiments were of the highest interest, and they led to the following conclusions:—(1) A good aneroid of large size may be corrected for temperature by an optician, so that the residual correction shall be very small. (2 α) If an aneroid correct, to commence with, be used for a balloon or mountain ascent, it will be tolerably correct for a decrease of about 6 inches of pressure. (2 β) A large aneroid is more likely to be correct than a small one. (2 γ) The range of correctness of an instrument used for mountain ascents may be increased by a previous verification, a table of corrections being thus obtained. (3 α) If an aneroid have remained some time at the top of a mountain, and be supposed correct to start with, then it will give good results for about 8 inches of increase of pressure. (3 β) If the aneroid has been previously verified, it is likely to give a better result. (4) After being subjected to sudden changes of pressure the zero of an aneroid gradually changes, so that under such circumstances it ought only to be used as a differential and not as an absolute instrument, that is to say, used to determine the distance ascended, making it correct to begin with, or to ascertain the distance descended, making it correct to begin with, it being understood that the instrument ought to be quiescent for some time before the change of pressure is made.

Influence of Pressure on the Combustion of Gases.—Dr. Frankland has been trying the effect of pressure on the combustion of hydrogen and carbonic-oxide in oxygen, and has found very remarkable results. The appearance of a jet of hydrogen burning in oxygen is known to everyone. On increasing the pressure to two atmospheres, the light is much increased; but on increasing it to ten atmospheres, the light emitted by a jet an inch long is amply sufficient to enable the observer to read a newspaper at a distance of two feet from the flame, and this without any reflecting surface behind the flame. Seen with the spectroscope the spectrum of the flame is bright and perfectly continuous from red to violet. The carbonic oxide is still more intense under similar circumstances.

Effect of Nuclei in Crystallisation.—Mr. Tomlinson's conclusions on this interesting point may be thus summed up:—(1) That a number of hydrated salts form supersaturated solutions, and remain so even at low temperatures simply from the absence of a nucleus to start the crystallisation. (2) That a nucleus is a body that has a stronger adhesion for the salt than for the water which holds the salt in solution, a state of things brought about by the absence of chemical purity. (3) That three or four salts form supersaturated solutions, which in cooling down deposit a modified salt or one of a lower degree of hydration than the normal salts. (4) That this modified salt is formed first by the deposit, in small quantity, of the anhydrous salt, which entering into solution, forms a dense lower stratum containing less water than the rest of the solution, in which lower stratum the chemical purity can be reduced to low temperatures without crystallising. Mr. Tom-

linson contends that supersaturation exists in fact, as well as in appearance, and that there is no proof of any molecular change in such solutions, such as to lead to the formation of a more soluble salt.

The Magnetic Polarity of Magnetic Oxide of Iron.—M. Sidot has already shown that iron-pyrites may be given magnetic polarity by passing a current of hydrosulphuric acid over the magnetic oxide. He now states that the direction of the polar axis appears to be in relation to the position of matters at the moment of their formation with reference to the magnetic axis of the globe. M. Sidot has tested his supposition further by examining the behaviour of the oxide of iron, Fe_3O_4, examining whether it suffered the same physical modifications, being placed in the same conditions, as magnetic pyrites, and whether the polarity was produced by the earth by removing all causes foreign to terrestrial action. When a tube of refractory clay is placed parallel to the magnetic needle, in a furnace free from iron, and in the tube a platinum boat filled with colcothar, which is heated to bright redness in a current of air for an hour, the result, after cooling, is a strongly agglomerated grey oxide possessed of magnetic polarity. The extremity of the oxide turned towards the north is a south pole; it energetically repulses the pole of a magnetic needle pointing to the north of the earth. Magnetic oxide is likewise obtained by calcining colcothar in a platinum crucible. The upper extremity of the mass presents a pole opposed to the south pole of the globe, and the lower extremity an opposite pole. To obtain masses possessed of greater magnetic polarity a different disposition was made. A piece of iron plate, in the form of a tube, was suspended in a clay tube, placed vertically in a furnace traversed by a very rapid current of air, and heated to bright redness for the time necessary for the complete oxidation of the iron. Tubes of oxide were thus obtained possessed of magnetic polarity, and strongly repulsing the poles of the magnetic needle. The polarity is always dependent upon the position of the iron plate. The magnet produced in this way was replaced in the furnace, reversed, and heated in the same conditions of temperature as before for one hour; after cooling, the poles were found to be reversed; that pole which is formed at the upper extremity is always similar to the north pole of the earth.—Foreign Correspondence, *Chemical News.*

A simple and useful Form of Aspirator is thus described by Professor Leeds, in a recent number of the *American Journal of Science*:—A pail containing water is placed at the edge of the table, and to a stop-cock which is attached to the side of the pail near the bottom a tube of two or three feet in length is connected, to carry off the water to a bucket placed on the floor below. When the bucket is filled, the stop-cock is turned off for a moment, and the water poured back into the pail. To the top of the stop-cock tube, which should be made straight and somewhat longer than usual, and in front of the stop-cock itself, a short vertical tube is attached, and connected by means of india-rubber tubing with the wash-bottle or other vessel through which gas is to be drawn. On partially opening the stop-cock, the deficiency of water is made up by a large quantity of air or gas, which is drawn in through the vertical tube above mentioned.

Scientific Photometry.—The old sperm candle is known to all who have used it to be a most unreliable standard for photometric observation. Mr. W.

Crookes, F.R.S., has, however, devised a substitute for it in the shape of a lamp, which meets nearly all the wants of the operation. A glass lamp is taken of about 2 ounces capacity, the aperture in the neck being 0·25 inch diameter; another aperture at the side allows the liquid fuel to be introduced, and by a well-known laboratory device, the level of the fluid in the lamp can be kept uniform. The wick-holder consists of a platinum tube 1·81 inch long and 0·125 inch internal diameter. The bottom of this is closed with a flat plug of platinum, apertures being left in the sides to allow free access of spirit. A small platinum cup ·5 inch diameter and ·1 inch deep is soldered round the outside of the tube 0·5 inch from the top, answering the threefold purpose of keeping the wick-holder at a proper height in the lamp, preventing evaporation of the liquid, and keeping out dust. The wick consists of 52 pieces of hard-drawn platinum wire, each 0·01 inch in diameter and 2 inches long, perfectly straight, and tightly pushed down into the platinum holder until only 0·1 inch projects above the tube. The height of the burning fluid in the lamp must be sufficient to cover the bottom of the wick-holder: it answers best to keep it always at the uniform distance of 1·75 inch from the top of the platinum wick; a slight variation of level, however, has not been found to influence the light to an extent appreciable by our present means of photometry. The lamp having the reservoir of spirit thus arranged, the platinum wires parallel, and their projecting ends level, a light is applied, and the flame instantly appears, forming a perfectly-shaped cone 1·25 inch in height, the point of maximum brilliancy being 0·56 inch from the top of the wick. The extremity of the flame is perfectly sharp, without any tendency to smoke; without flicker or movement of any kind, it burns, when protected from currents of air, at a uniform rate of 136 grains of liquid per hour. The temperature should be about 60° F., although moderate variations on either side exert no perceptible influence. Bearing in mind Dr. Frankland's observations on the direct increase in the light of a candle with the atmospheric pressure, accurate observations ought only to be taken at one height of the barometer. To avoid the inconvenience and delay which this would occasion, a table of corrections should be constructed for each 0·1 inch variation of barometric pressure.

The Spectrum of Potassium.—Mr. J. H. Freeman, in a communication to the *Chemical News* (July 3), says, that of the seventeen lines which constitute the most characteristic part of the potassium spectrum, some make their appearance at a lower temperature than others. If a mixture of 10 eqs. of potassic nitrate, 10 eqs. of sulphur, and 3 eqs. of charcoal be ignited, and the light produced analysed by a spectroscope, it will be found that the double line at 130 on Bunsen and Kirchoff's scale, the line at 430, the triple line at 1,120, and the line at 3,160 will be visible; whilst the triple line at 1,300, the triple line at 1,530, the triple line at 1,760, and the line in the blue will be invisible. But if in the mixture we substitute potassic chlorate for the potassic nitrate, it will be found that all the lines, with the exception of the one in the blue, will come into view. But it is well known that the temperature produced during the combustion of $KClO_3$ and sulphur is much higher than the temperature of the combustion of KNO_3 and sulphur; and a gradual increase of temperature from that produced by KNO_3 and sulphur,

up to that produced by $KClO_3$, may be obtained by gradually abstracting the KNO_3 and supplying $KClO_3$ in its place; so that by gradually increasing the temperature of the combustion, it was found that the order in which the lines made their appearance was—1st, the line at 130, the line at 430, the triple line at 1,120, and the line at 3,160; 2nd, the triple line at 1,530; 3rd, the triple line at 1,300; 4th, the triple line at 1,760; but the line in the blue remained invisible when the whole of KNO_3 was abstracted, and its place supplied by $KClO_3$.

A new Gas Lamp, termed the Bourbouze, is now being used in France, and is said to be as brilliant as the oxyhydrogen light, and less expensive. Coal gas, intimately mixed with air, is urged with gentle pressure along a tube, and made to pass through a metallic plate pierced full of minute holes. By this means a vast number of jets are obtained, which, after being driven through a fine tissue of platinum wire, are lighted in the ordinary way. The platinum soon acquires a white heat, and gives out so brilliant a light that it cannot be supported by the naked eye. About one cubic metre of gas is consumed per hour.

ZOOLOGY AND COMPARATIVE ANATOMY.

The Mole-rats.—M. Alph Milne Edwards has published a memoir on these creatures. He states that they afford an illustration of the fact, that the modifications by which animals adapt themselves to conditions of existence are given too great an importance by zoologists. "Most zoologists," he says, "have ranged under the same group the rodents which live underground, hollow out galleries in the earth by means of their claws, and feed upon the roots and bulbs of plants. These rodents have, in their general appearance, something which calls to mind the mole; the body is more or less cylindrico-conical, and is borne on short stout limbs, and the eyes are frequently almost indistinct. Hence the group has been called the mole-rats. It is divided into a certain number of genera, as *Bathyergus*, *Georhycus*, *Heliophobius*, *Spalax*, *Elobius*, and *Siphneus*. The group thus formed is essentially artificial, and is composed of animals widely different. M. Milne Edwards then proceeds to demonstrate the errors of the naturalists who have considered this group, and to show how little affinity exists between certain of the species composing it."—*Comptes Rendus*, August 17.

The Artificial Inversion of the Viscera.—M. Dareste, who is certainly one of the most distinguished of modern teratologists, has made known the results of some very curious researches recently undertaken, to determine how far inversion could be effected by experimental means. The inversion of the viscera is very rare in man, and still rarer in the other animals. Indeed, prior to M. Dareste's observations, but one instance had been recorded, that of the embryo of a fowl by Von Bär. "The embryo," says M. Dareste, "is in the commencement completely symmetrical. It is only at a certain period of its evolution that it deviates from this arrangement; but this deviation may occur abnormally, and then there is inversion of the viscera, or, more technically, *heterotaxy*." M. Dareste adduces numerous facts to show that

abnormal deviations result from the left region of the vascular area being more developed than the right; and he says, that if the experiments can bring about this increased development, he can produce inversion artificially. The method he gives for the production of this phenomenon in the hen-egg, is simple enough. Place the eggs so that their long axis is obliquely situate in relation to the axis of the heating tubes of the apparatus, and let the pointed end be always higher than the round one.

The Formation of the Ovule.—At a recent meeting of the Academy of Sciences of Paris, M. Perez presented a paper in which he advanced certain views on this point. M. Davaine now (*Comptes Rendus*, August 24) claims the priority, and quotes passages from his "Mémoire sur l'Anguillule de la Nielle," which show very clearly that his claim is a just one.

Arterial Capillaries in Insects.—This much-debated point seems to be decided in the affirmative by the researches of M. Jules Künckel, who states that he has convinced himself of the existence of a series of arterial capillaries in insects. These, he says, divide and ramify in the finest divisions, not only in the muscles, but in the various organs of the body. Generally the blood examined by transmitted light presents a reddish colour which renders the capillaries distinct. When the blood leaves the vessels, as he has often seen it do, they lose all their colour. It is easy to see the trachea, but very difficult to distinguish the capillaries, their walls are so thin and transparent. "The difficulties of observation," says M. Künckel, "are very great. It is necessary to take a bundle of muscular fibre from the living animal, and place it at once beneath the microscope; then, under favourable circumstances, the blood may be seen flowing rapidly from the capillaries." For these researches a high magnifying power is necessary, and M. Künckel recommends the employment of immersion lenses. The capillaries would seem, from the author's statement, either to be formed by or to be adherent to the outer wall of the trachea; the inner wall does not proceed far into the tissue, but ends as a *cul de sac*, while the outer one is continued on to constitute the capillaries.—*Comptes Rendus*, July 27.

The Retina of the Hedgehog.—In a paper read before the Royal Society, Mr. J. W. Hulke stated that this retina is very remarkable from the fact that all the arteries and veins lie upon the inner surface of the membrana limitans interna retinæ, in intimate relation with the membrana hyaloidea; while capillaries only traverse the limitans, receiving a sheath from it, and penetrate the inner layers of the retina. The hedgehog's retina is in this respect a link between the non-vascular retina of fish, amphibia, reptiles and birds, and the vascular retinæ of most mammals.

The Avine Fauna of Madagascar and the neighbouring Islands.—The last number of the *Proceedings of the Royal Society* contains a very interesting communication from Messrs. A. and E. Newton on the osteology of the solitaire. Besides discussing the osteological part of their problem, the authors make the following highly suggestive remarks:—Of the other terrestrial members of the avifauna of Rodriguez but few now remain. A small finch and a warbler, both endemic (the first belonging to a group almost entirely confined to Madagascar and its satellites, the second to a genus extending from Africa to Australia), are the only two land-birds of its original fauna now known to exist. The guinea-fowl and love-bird have in all pro-

bability been introduced from Madagascar; but the parrots and pigeons of which Leguat speaks have vanished. The remains of one of the first, and the description of the last, leave little room to doubt that they also were closely allied to the forms found in Madagascar and the other Mascarene islands; and thus it is certainly clear that *four* out of the *six* indigenous species had their natural allies in other species belonging to the same zoological province. It seems impossible on any other reasonable supposition than that of a common ancestry to account for this fact. The authors are compelled to the belief that there was once a time when Rodriguez, Mauritius, Bourbon, Madagascar, and probably the Seychelles, were connected by dry land, and that that time is sufficiently remote to have permitted the descendants of the original inhabitants of this now submerged continent to become modified into the many different representative forms which are now known. Whether this result can have been effected by the process of "Natural Selection" must remain an open question; but that the solitaire of Rodriguez, and the dodo of Mauritius, much as they eventually came to differ, sprang from one and the same parent stock, seems a deduction so obvious, that the authors can no more conceive any one fully acquainted with the facts of the case hesitating about its adoption, than that he can doubt the existence of the Power by whom these species were thus formed.

The Whitebait a Herring.—In a paper before the Zoological Society, Dr. Günther, in dealing with the clupeoids of the British coasts, gave it as his opinion that the whitebait is really a young herring. We are glad to learn the belief of one of the most eminent of European ichthyologists, and the more so as it confirms the opinion expressed in an article in one of our earlier volumes, in which the writer expressed his conviction, that the anatomical affinities of the herring and whitebait were so close as to justify their being grouped into one species.

The forthcoming Volumes of the Ray Society.—The treatises of the *Ray Society* in preparation are as follows:—Professor Allman on the British Corynidæ; Rev. O. P. Cambridge, a supplementary volume on British Spiders; Messrs. Douglas and Scott on the British Hemiptera Homoptera; Dr. Gaertner on Hybridism in Plants (Bastarderzeugung), translated from the German by W. Carruthers, Esq., F.L.S.; Mr. Hancock on the British Tunicata; Herr Kaltenbach's Phytophagous Insects, translated from the German by H. T. Stainton, F.R.S.; Sir John Lubbock on the British Thysanura; Dr. M'Intosh on the British Annelids; Mr. St. George Mivart, Monograph of the Tailed Amphibia; Mr. Andrew Murray on the Coniferæ; A Synopsis of the Fauna and Flora of Palestine, by the Rev. H. B. Tristram, F.L.S.; and Professor Westwood on the Mantidæ, with illustrations by Mr. E. A. Smith.

Mr. Berkeley on Mr. Darwin's Views.—Mr. Berkeley, as President of the Botanical Section of the British Association, commented, in the course of his address, on Mr. Darwin's theory of Pangenesis—perhaps the most remarkable doctrine of modern material philosophy, and by no means the least probable. "Others," said Mr. Berkeley, "as Owen and Herbert Spencer, had broached something of the kind, but not to such an extent, for the Darwinian theory included atavism, reversion, and inheritance, and embraced mental peculiarities as well as physical. The whole matter was at

once so complicated, and the theory so startling, that the mind at first naturally shrank from the reception of so bold a statement. Like everything, however, which came from the pen of a writer whom he had no hesitation, as far as his judgment went, in considering as by far the greatest observer of the age, whatever might be thought of his theories when carried out to their extreme results, the subject demanded a careful and impartial consideration. Like the doctrine of natural selection, it was sure to modify more or less their modes of thought. Even supposing the theory unsound; it was to be observed, as Whewell remarked, as quoted by their author, 'Hypotheses may often be of service to science when they involve a certain portion of incompleteness and even of error.' Mr. Darwin said himself that he had not made histology an especial branch of study, and he (Mr. Berkeley) had, therefore, less hesitation in expressing an individual opinion that he had laid too much stress on free cell formation, which was rather the exception than the rule.* Assuming the general truth of the theory that molecules endowed with certain attributes were cast off by the component cells, of such infinitesimal minuteness as to be capable of circulating with the fluids, and in the end to be present in the unimpregnated embryo cell and spermatozoid, capable either of lying dormant or inactive for a time, or when present in sufficient potency of producing certain definite effects, it seemed far more probable that they should be capable, under favourable circumstances, of exercising an influence analogous to that which is exercised by the contents of the pollen tube or spermatozoid on the embryo sac than that these particles should be themselves developed into cells; and under some such modification the theory was far more likely to meet with anything like a general acceptation."

What is Natural Selection?—It is to be hoped that the Mr. Harrison who was so funny on the subject of the Darwinian theory at the British Association will take up some elementary work, and make himself familiar with the principles involved in the term Natural Selection. Anything more ridiculous than the following objection to Darwinianism we have not yet met with:—"With regard to acorns dropping upon the ground, it often happened that the smallest ones sprang up while the largest ones died. It was external circumstance merely that decided the question, and it had nothing to do with 'natural selection.'" Mr. Harrison is one of those who would say the moon is not the moon because it is a planet.

The Lingual Membrane of Mollusca.—In a very interesting paper in the *Quarterly Journal of Microscopical Science*, Mr. Jabez Hogg, Sec. R.M.S., describes the peculiar dental structures of the tongues and palates of mollusks, and attempts to furnish a scheme for classification. Mr. Hogg's paper is so essentially a paper of details that it would be impossible to abstract it here. The author's observations have been made in part upon a very valuable collection (the Woodwardian) in the possession of Mr. F. G. Edwards. We are not so sanguine as Mr. Hogg in the belief that the study of the "odontophore" and mandible will one day reveal the "origin of species

* Mr. Darwin's theory only assumes the formation of a cell from a molecule. This is not free cell formation, and it is not the exception, but indeed the rule, in the development of animal tissues.—Ed. P.S.R.

among the mollusca." Nor do we think that a classification based solely on any particular organ can be a sound one. Nevertheless, Mr. Hogg has done good service in developing Dr. J. E. Gray's view, and the illustrations which accompany his memoir are both numerous and excellent.

The Sexual Reproduction of Infusoria.—Dr. Ernst Eberhard's excellent paper on this subject, in the *Zeitschrift für wissenschaftliche Zoologie,* has been partly reproduced in the *Quart. Jour. Micro. Science,* for July. The abstract is comprehensive and interesting. Dr. Eberhard confirms some of Stein's observations, but has failed to convince himself of the accuracy of others. Having very carefully watched a number of *Bursaria truncatella,* he found that they became filled with a number of uniform globular particles—indeed, some of them seemed mere saccules of these bodies. Soon, however, he saw that these bodies were protruded through "the still open slit in the parent body," but they remained attached to its outer surface. After the parent had been disintegrated the globular bodies, now at liberty, developed a contractile vesicle and spherical nucleus, and presented an acineta-like form, whilst "short tentacles, with transparent nodular extremities, sprung up irregularly all over the surface." Shortly, cilia presented themselves on the surface. In fact, as Dr. Eberhard observes, here was an acinetaform which is at some time one of the Ciliata. In this case the embryos all originated in the nucleus of the parent. "It would seem," says the writer of the abstract, "that the points at which the author is at issue with Stein are: (1) That while the latter observer insists upon the presence of a nucleus in all the individuals filled with embryos, the author denies its existence; (2) Stein positively denies the occurrence of the acinetaform progeny, whilst the author asserts it; (3) Stein places the contractile vesicle in the hinder part of the embryo; Dr. Eberhard says it is placed anteriorly."

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THE

POPULAR SCIENCE REVIEW.

A QUARTERLY MISCELLANY OF ENTERTAINING AND INSTRUCTIVE ARTICLES ON SCIENTIFIC SUBJECTS.

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